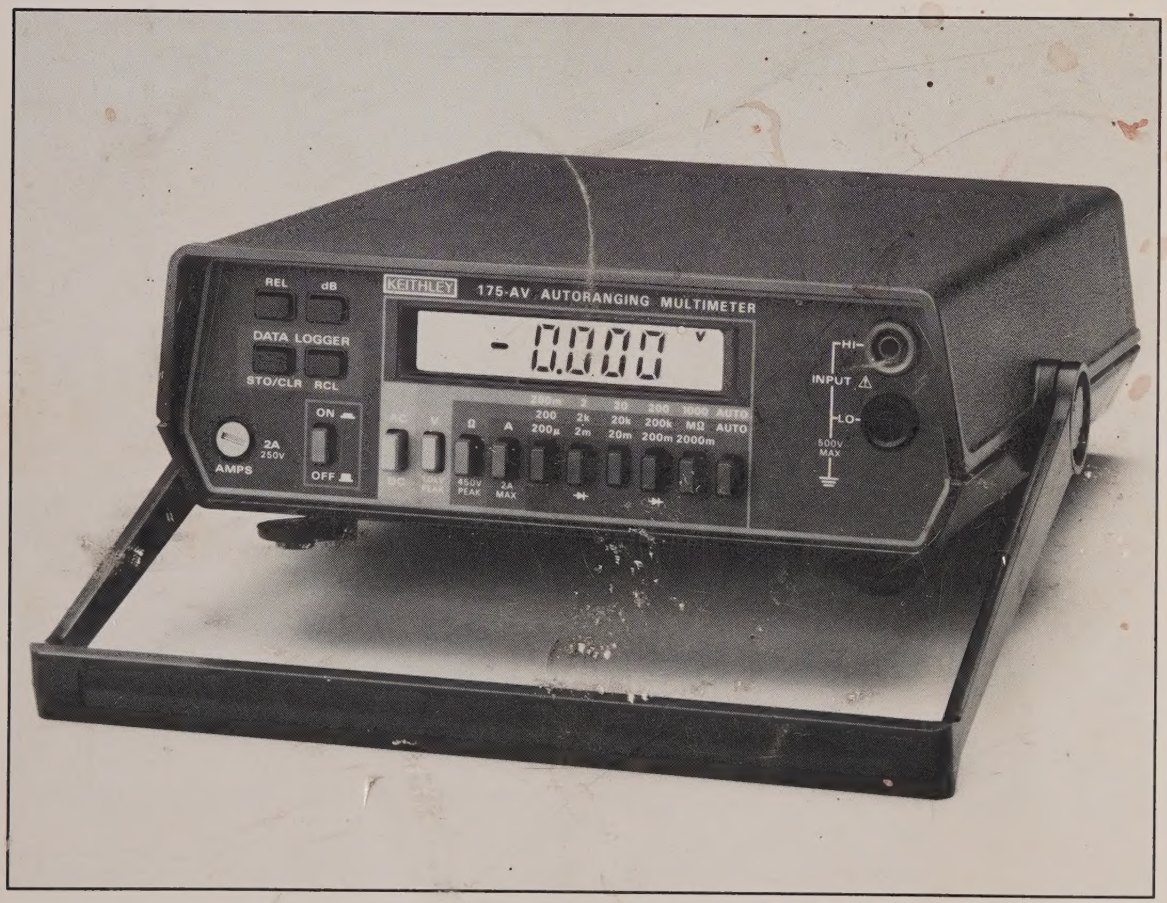
KEITHLEY INSTRUMENTS

Model 175-AV Autoranging Multimeter Instruction Manual



Contains Operating and Servicing Information

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Instruction Manual
Model 175-AV
Autoranging Multimeter

Serial Number 479210

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SAFETY PRECAUTIONS

The following safety precautions should be observed before operating the Model 175-AV.

This instrument is intended for use by qualified personnel who recognize shock hazards and are familiar with the safety precautions required to avoid possible injury. Read over the manual carefully before operating this instrument.

Exercise extreme caution when a shock hazard is present at the instrument's input. The American National Standards Institute (ANSI) states that a shock hazard exists when voltage levels greater than 30V rms or 42.4V peak are present. **A good safety practice is to expect that a hazardous voltage is present in any unknown circuit before measuring.**

Inspect the test leads for possible wear, cracks or breaks before each use. If any defects are found, replace the test leads.

For optimum safety do not touch the test leads or the instrument while power is applied to the circuit under test. Turn the power off and discharge all capacitors before connecting or disconnecting the instrument.

Do not touch any object that could provide a current path to the common side of the circuit under test or power line (earth) ground. Always make measurements with dry hands while standing on a dry, insulated surface, capable of withstanding the voltage being measured.

Exercise extreme safety when testing high energy power circuits (ac line or mains, etc.). Refer to High Energy Circuit Safety Precautions found in paragraph 2.2.

Do not exceed the instrument's maximum allowable input as defined in the specifications and operation section.

Instrumentation and accessories should not be connected to humans.

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MODEL 175-AV SPECIFICATIONS

DC VOLTS

RANGE	RESOLUTION	ACCURACY (1 Year) 18°–28°C ±(%rdg + counts)
200 mV	10 µV	0.03 + 3
2 V	100 µV	0.03 + 2
20 V	1 mV	0.03 + 2
200 V	10 mV	0.03 + 2
1000 V	100 mV	0.03 + 2

INPUT RESISTANCE: 11MΩ on 200mV, 2V, and 20V ranges. 10MΩ on 200V and 1000V ranges. (>1000MΩ on the 200mV and 2V ranges with all function buttons in the out position.)
NORMAL MODE REJECTION RATIO: >60dB at 50Hz, 60Hz ±0.15%.
MAXIMUM ALLOWABLE INPUT: 1000V DC or peak AC (<10 sec. per minute on 200mV and 2V ranges; 300V rms continuous).
SETTLING TIME: 1 sec. to within 1 count of final reading on range.
dB MODE (ref: 600Ω): Accuracy: ±(0.02dB + 1 count) (above –78dBm). **Resolution:** 0.01dB above 5% of range.

AC VOLTS

(average responding)

RANGE	ACCURACY (1 Year)* 18°–28°C ±(%rdg + counts) 20Hz–50Hz	50Hz–10kHz	10kHz–20kHz	20kHz–50kHz	50kHz–100kHz
2V–750V	1 + 20	0.5 + 20	1 + 40	2.5 + 75	5 + 200
200 mV	1 + 20	0.5 + 20	1.5 + 40	8 + 75	—

*Above 1800 counts.
MAXIMUM ALLOWABLE INPUT: 750V rms, 1000V peak (<10 seconds per minute on 200mV range; 300V rms continuous). 10^7V•Hz maximum.
3dB BANDWIDTH: 300kHz typical.
INPUT IMPEDANCE: 10MΩ paralleled by <75pF on 20V, 200V, and 1000V ranges. 11MΩ on 200mV and 2V ranges. Capacitively coupled.
SETTLING TIME: 2 seconds to within 15 counts of final reading on range.
dB MODE (ref: 600Ω):

RANGE	INPUT	ACCURACY (±dBm) 20Hz–10kHz	10kHz–20kHz	20kHz–50kHz	50kHz 100kHz
2V–750V	200 mV to 750 V (–12 to +59.8dBm)	0.2	0.26	0.56	1.2
200 mV	20 mV to 200 mV (–32 to –12 dBm)	0.2	0.3	1	—
	2 mV to 20 mV (–52 to –32 dBm)	2	3	—	—
	1 mV to 2 mV (–58 to –52 dBm)	2*	—	—	—

Resolution: 0.01dB above 5% of range. *Up to 1kHz.

OHMS

RANGE	RESOLUTION	ACCURACY (1 Year) 18°–28°C ±(%rdg + counts)	MAX. VOLTAGE ACROSS UNKNOWN ON RANGE
200 Ω	10 mΩ	0.05 + 2*	0.2 V
2 kΩ	100 mΩ	0.05 + 1	2.0 V
20 kΩ	1 Ω	0.05 + 2	0.2 V
200 kΩ	10 Ω	0.05 + 1	2.0 V
2 MΩ **	100 Ω	0.05 + 2	0.2 V
20 MΩ **	1 kΩ	0.2 + 1	2.0 V
200 MΩ **	100 kΩ	2.0 + 1	2.0 V

*When properly zeroed. **Appropriate range selected automatically.
MAXIMUM ALLOWABLE INPUT: 450V DC or peak AC.
OPEN-CIRCUIT VOLTAGE: +5V.
DIODE TEST: Display reads junction voltage up to 2V. Test current: 0.7mA nominal.
SETTLING TIME: 2 seconds to within 1 count of final reading on range.

DC AMPS

RANGE	RESOLUTION	MAXIMUM VOLTAGE BURDEN	ACCURACY (1 Year) 18°–28°C ±(%rdg + counts)
200 µA	10 nA	0.25 V	0.15 + 2
2 mA	100 nA	0.25 V	0.15 + 2
20 mA	1 µA	0.25 V	0.15 + 2
200 mA	10 µA	0.25 V	0.2 + 2
2000 mA	100 µA	0.5 V	0.2 + 2

OVERLOAD PROTECTION: 2A fuse (250V), externally accessible.
SETTLING TIME: 1 second to within 1 count of final reading.

AC AMPS

(average responding)

RANGE	MAXIMUM VOLTAGE BURDEN	ACCURACY (1 Year)* 18°–28°C ±(%rdg+counts) 20Hz–50Hz	50Hz–10kHz	10kHz–30kHz
200µA–20mA	0.25 V	1 +20	0.8 + 20	2 + 50
200 mA	0.25 V	1 +20	0.8 + 20	—
2000 mA	0.5 V	1 +20	0.8 + 20	—

*Above 1800 counts.

SETTLING TIME: 2 seconds to within 15 counts of final reading.

IEEE-488 BUS IMPLEMENTATION (Model 1753 Option)
MULTILINE COMMANDS: DCL, SDC, GET, GTL, UNT, UNL, SPE, SPD.
UNILINE COMMANDS: IFC, REN, EOI, SRQ, ATN.
INTERFACE FUNCTIONS: SH1, AH1, T5, TE0, L4, LE0, SR1, RL2, PP0, DC1, DT1, C0, E1.
PROGRAMMABLE PARAMETERS: Range, REL, dB, EOI, Trigger, Calibration, SRQ, Status, Output Format, Terminator.

GENERAL

DISPLAY: 4-1/2 digit LCD, 0.5 in. height; polarity, function, range, and status indication.
RANGING: Auto or manual on DC volts, AC volts, ohms; manual on AC amps, DC amps.
AUTORANGING TIME: 300msec. per range.
WARMUP: 1 hour to rated accuracy.
RELATIVE: Pushbutton allows zeroing of on range readings. Allows readings to be made with respect to baseline value. Front panel annunciator indicates REL mode.
DATA LOGGER and MIN/MAX: 100 reading storage capacity; records data at one of six selectable rates from 3 readings/second to 1 reading/hour. Also detects and stores maximum and minimum readings continuously in data logger mode.
CONVERSION RATE: 3 readings per second.
OVERRANGE INDICATION: "OL" displayed.
MAXIMUM COMMON MODE VOLTAGE: 500V peak.
COMMON MODE REJECTION RATIO (1kΩ unbalance): >120dB at DC, 50Hz, 60Hz ±0.15%. >60dB in AC volts.
TEMPERATURE COEFFICIENT (0°–18°C & 28°–50°C): ±(0.1 × applicable accuracy specification)/°C except ±(0.07%+2)/°C for 50Hz–10kHz in AC volts.
ENVIRONMENT: Operating: 0° to 50°C; <80% relative humidity up to 35°C; linearly derate 3% RH/°C, 35° to 50°C. **Storage:** –40°C to +60°C.
POWER: 105–125V or 210–250V (external switch selected), 50–60Hz, 12VA. Optional 6-hour battery pack, Model 1758.
DIMENSIONS, WEIGHT: 89mm high × 235mm wide × 275mm deep (3.5 in. × 9.25 in. × 10.75 in.). Net weight 1.8kg (3 lbs., 14 oz.).
ACCESSORIES SUPPLIED: Model 1751 Safety Test Leads, instruction manuals (2).
ACCESSORIES AVAILABLE:

Model 1010:	Single Rack Mounting Kit
Model 1017:	Dual Rack Mounting Kit
Model 1301:	Temperature Probe (–55°C to +150°C)
Model 1600A:	High Voltage Probe (40kV)
Model 1651:	50A Current Shunt
Model 1681:	Clip-On Test Lead Set
Model 1682A:	RF Probe (250MHz)
Model 1684:	Hard Shell Carrying Case
Model 1685:	Clamp-On Current Probe (200A)
Model 1751:	Safety Test Leads
Model 1753-AV:	IEEE-488 Interface
Model 1754:	Universal Test Lead Kit
Model 1755:	Calibration Interface
Model 1758:	Rechargeable Battery Pack
Model 7008-3:	IEEE-488 Digital Cable, 0.9m (3 ft.)
Model 7008-6:	IEEE-488 Digital Cable, 1.8m (6 ft.)

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SECTION 1
General Information

1.1 INTRODUCTION

The Keithley Model 175-AV is a 4-1/2 digit LCD bench/portable digital multimeter. The Model 175-AV can make the following basic measurements:

1. Dc voltage measurements from 10μV to 1000V.
2. Resistance measurements from 10mΩ to 200MΩ.
3. Ac voltage measurements from 10μV to 750V.
4. Dc current measurements from 10nA to 2A.
5. Ac current measurements from 10nA to 2A.

In addition to the above mentioned measurement capabilities, the Model 175-AV can make dc and ac dB voltage measurements.

1.2 FEATURES

Some important Model 175-AV features include:

- 4-1/2 digit LCD display
- Fast autoranging
- Bench or portable
- Digital calibration
- 100-point data logger
- 0.03% basic dcV accuracy
- Average responding acV and acA
- dBm/Relative functions
- Min/Max reading hold
- Safety input jacks
- 100kHz specified ac bandwidth

Options include:

- Model 1758 Rechargeable Battery Pack
- Model 1753-AV IEEE-488 Interface

1.3 WARRANTY INFORMATION

Warranty information may be found on the inside front cover of this manual. Should it be necessary to exercise the warranty, contact your Keithley representative or the factory to determine the proper course of action. Keithley Instruments maintains service facilities in the United States, United Kingdom, and throughout Europe. Information concerning the application, operation, or service of your instrument may be directed to the applications engineer at any of these locations. Check the inside front cover for addresses.

1.4 MANUAL ADDENDA

Information concerning improvements or changes to the instrument that occur after the printing of this manual will be found on an addendum sheet included with the manual. Be sure to review these changes before attempting to operate or service the instrument.

1.5 SAFETY SYMBOLS AND TERMS

The following safety symbols and terms are used in this manual or found on the Model 175-AV.

The symbol on the instrument denotes that the user should refer to the operating instructions in this manual.

The on the instrument denotes that a hazardous potential may be present on the terminal(s). Standard safety practices should be observed when such dangerous levels are encountered.

The **WARNING** used in this manual explains dangers that could result in personal injury or death.

The **CAUTION** used in this manual explains hazards that could damage the instrument.

1.6 SPECIFICATIONS

Detailed Model 175-AV specifications may be found preceding the Table of Contents of this manual.

1.7 INSPECTION

The Model 175-AV Autoranging DMM was carefully inspected, both electrically and mechanically, before shipment. After unpacking all items from the shipping carton, check for any obvious signs of physical damage that might have occurred during transit. Report any damage to the shipping agent. Retain and use the original packing materials in case reshipment is necessary. The following items are shipped with every Model 175-AV order:

Model 175-AV Autoranging Multimeter

Model 175-AV Instruction Manuals (2)

Model 1751 Safety Test Leads

Additional accessories as ordered.

If an additional instruction manual is required, order the manual package (Keithley Part Number 175AV-901-00). The manual package includes an instruction manual and any applicable addenda.

1.8 USING THE MODEL 175-AV MANUAL

This manual contains information necessary for operating and servicing the Model 175-AV Autoranging Multimeter and the Model 1758 Rechargeable Battery Pack. The information is divided into the following sections:

- Section 1 contains general information about the Model 175-AV and Model 1758, including that necessary to inspect the instrument and get it operating as quickly as possible.
- Section 2 contains detailed operating information on using the front panel controls, making connections, and basic measuring techniques for each of the available measuring functions.
- Section 3 contains performance verification procedures for the instrument. This information will be helpful if you wish to verify that the instrument is operating in compliance with its stated specifications.
- Section 4 contains a description of operating theory. Analog, digital, and power supply operation is included.
- Section 5 contains information for servicing the instrument. This section includes information on line fuse replacement, line voltage selection, calibration and troubleshooting.
- Section 6 contains replaceable parts information.

NOTE
The Model 1753-AV IEEE-488 interface comes supplied with its own instruction manual.

1.9 GETTING STARTED

Perform the following steps in sequence to acquaint yourself quickly and safely with the basic operation of the Model 175-AV.

1. Connect the female end of the power cord to the ac receptacle on the rear panel of the instrument. Connect the other end of the cord to a grounded ac outlet. If the optional battery pack is installed the charge circuitry will be activated. Refer to paragraph 2.3.1 for more complete information.
2. Turn on the Model 175-AV by pressing in the ON/OFF pushbutton. All of the zeros will be displayed briefly.
3. Connect the supplied test leads to the INPUT HI and LO jacks, and short them together.
4. Select ac volts and autoranging by pressing in the AC/DC, V, and AUTO pushbuttons. The AC, mV, and AUTO annunciators will be displayed. Pressing any of the other range pushbuttons will put the Model 175-AV in manual ranging as indicated by the absence of the AUTO annunciator.
5. Select dc volts by releasing (out) the AC/DC pushbutton (V still selected). The AC annunciator will turn off.
6. Select autoranging ohms by pressing in the Ω pushbutton (dc still selected) and AUTO pushbutton. The Ω annunciator will turn on. Press the AC/DC pushbutton in (ac selected) and note the "Err" message indicating that this is an invalid mode.
7. Select ac or dc current by setting the AC/DC pushbutton accordingly and pressing in the A pushbutton. The annunciator that reflects the selected range will turn on. Note that current will not autorange.
8. Select dB by placing the Model 175-AV in ac or dc volts and pressing the dB pushbutton. The dB annunciator will turn on. Press the dB button again to take the Model 175-AV out of the dB measurement mode.

9. REL (relative) can be used with any measurement function: volts, ohms, amps or dB. For example, place the Model 175-AV in ohms and autorange. The display will read approximately 00.14Ω, which is the test lead resistance. Press the REL pushbutton. The REL annunciator will turn on and the display will now read 00.00Ω. The relative level of 0.14Ω will be subtracted from all subsequent ohm measurements. Press the REL pushbutton a second time to cancel the REL level.
10. To activate the 100-point DATA LOGGER with MIN/MAX, press and hold in the STO/CLR pushbutton. When the reading rate R=0 is displayed, let go of the button. The STO annunciator will turn on. Press the RCL pushbutton and the last data point will be displayed briefly followed by the reading (data). Other data points can be displayed by holding in the RCL button. Turn off the DATA LOGGER by pressing the STO/CLR pushbutton again.
11. When you are comfortable with the controls of the Model 175-AV, go on and make the desired measurements using Section 2, Bench Operation as a guide.

1.10 ACCESSORIES

The following accessories are available to enhance Model 175-AV capabilities:

Model 1010 Single Rack Mounting Kit — Use to mount one Model 175-AV in a standard 5-1/4 × 19" rack.

Model 1017 Dual Rack Mounting Kit — Use to mount two Model 175-AV's in a standard 5-1/4 × 19" rack.

Model 1301 Temperature Probe — A rugged low cost temperature probe designed to allow precision temperature measurements from –55°C to 150°C.

Range: –55°C to 150°C
Output: 1mV/°C; compatible with any DMM with at least 10MΩ input impedance.
Accuracy: ±2°C from 0° to 100°C; ±3°C from –55° to 0°C and 100° to 150°C
Power: 9V alkaline or C-Zn (NEDA 1604) battery.

Model 1600A High Voltage Probe — Extends the DMM to 40kV.

Maximum Input: 40kV dc or peak ac to 300Hz
Input Resistance: 1000MΩ
Division Ratio: 1000:1
Ratio Accuracy: ±2.5% from 1kV to 40kV DC, ±3.5% if 200mV or 2V ranges of Model 175-AV are used; –3dB at 300Hz ac.
Operating Temperature: 0° to 50°C

Model 1651 50-Ampere Current Shunt — The external 0.001Ω ±1%, 4-terminal shunt permits current measurements from 0-50A dc or ac.

Model 1681 Clip-On Test Lead Set — Contains two leads, 1.2m (48 inches) long terminated with banana plugs and spring action clip on probes.

Model 1682A RF Probe — Permits voltage measurements from 100kHz to 250MHz.

Ac to dc transfer accuracy: ±1dB from 100kHz to 250MHz at 1V, peak responding, calibrated in rms of a sine wave.
Maximum Allowable Input: 42V ac peak, 200V (dc + ac peak)

Model 1684 Hard Shell Carrying Case — Hard vinyl case, 100mm × 300mm × 350mm (4 × 13 × 14 inches) has a fitted foam insert with room for the Model 175-AV, instruction manual, and small accessories.

Model 1685 Clamp-On Ac Probe — Measures ac current by clamping onto a single conductor. Interruption of the circuit under test is unnecessary. The Model 1685 detects current by sensing the changing magnetic field produced by the current flow.

Range: 2, 20 and 200A rms
Accuracy: ±4% of range at 60Hz; ±6% of range at 50Hz
Temperature Coefficient: ±0.05%/°C on 20A and 200A range; ±0.3%/°C on 2A range
Maximum Allowable Current: 300A rms
Maximum Conductor Voltage: 600V rms
Conversion Ratio: 0.1V/A rms

Model 1751 Safety Test Leads — This is the test lead set supplied with each Model 175-AV. Finger guards and shrouded banana plugs help minimize the chance of making contact with live circuitry.

Model 1753-AV IEEE-488 Interface — Field installable programmable option provides isolated data output. Switch selectable talk only or addressable modes. Mounts within and powered by the Model 175-AV.

Model 1754 Universal Test Lead Kit — 12 piece test lead kit, with interchangeable plug-in accessories. Kit includes: one set of test leads (1-red, 1-black), two spade lugs, two standard banana plugs, two phone tips (.060 dia.), two hooks and two miniature alligator clips (with boots).

Model 1755 Calibration Interface — Permits automated IEEE-488 based verification and calibration of Model 175-AV without installed interface. An IEEE-488 interface must be installed in the 1755.

Model 1758 Rechargeable Battery Pack — Provides six hours minimum operation from full charge, recharges within 10 hours and is field installable.

Model 7008 IEEE-488 Digital Cable — Useful for connecting the Model 1753 to the IEEE-488 bus. The Model 7008-3 is 0.9m (3ft) in length and has a standard IEEE-488 connector at each end. The Model 7008-6 is 1.8m (6ft) in length.

SECTION 2
Bench Operation

2.1 INTRODUCTION

This section contains the information needed to prepare and operate the Model 175-AV as a bench DMM. Bench operation consists of using the Model 175-AV to perform basic voltage, current, resistance and dB measurements. Also, the operation of the data logger is covered here. The capabilities of the Model 175-AV can be enhanced with the addition of the Model 1753-AV IEEE-488 interface. IEEE operation is covered in the Model 1753 Instruction Manual.

2.2 HIGH ENERGY CIRCUIT SAFETY PRECAUTIONS

To optimize safety when measuring voltage in high energy distribution circuits, read and use the directions in the following warning.

WARNING

Dangerous arcs of an explosive nature in a high energy circuit can cause severe personal injury or death. If the meter is connected to a high energy circuit when set to a current range, low resistance range, or any other low impedance range, the circuit is virtually shorted. Dangerous arcing can result when the meter is set to a voltage range if the minimum voltage spacing is reduced.

When making measurements in high energy circuits use test leads that meet the following requirements:

- Test leads should be fully insulated.
- Only use test leads that can be connected to the circuit (e.g., alligator clips or spade lugs) for hands-off measurement.
- Do not use test leads that decrease voltage spacing. This diminishes arc protection and creates a hazardous condition.

Use the following sequence when testing power circuits:

1. De-energize the circuit using the regular installed connect-disconnect device such as the circuit breaker, main switch, etc.
2. Attach the test leads to the circuit under test. Use appropriate safety rated leads for this application.
3. Set the DMM to the proper function and range.
4. Energize the circuit using the installed connect-disconnect device and make measurements without disconnecting the DMM.
5. De-energize the circuit using the installed connect-disconnect device.
6. Disconnect the test leads from the circuit under test.

CAUTION

The maximum common-mode input voltage (the voltage between input LO and chassis ground) is 500V peak. Exceeding this value may damage the instrument.

2.3 PREPARATION FOR USE

2.3.1 Line Power

Use the following procedure to connect the Model 175-AV to line power and power up the instrument.

1. Check that the instrument is set to correspond to the available line power. Ranges are 105V-125V or 210V-250V 50/60Hz ac. If the line voltage setting of the instrument needs to be changed, set switch as required.

NOTE

Although the Model 175-AV is specified at 50 and 60Hz, the instrument may be operated at 400Hz and 440Hz. Add one count to instrument specifications under this condition.

2. Connect the female end of the power cord to the ac receptacle on the rear panel of the instrument. Connect the other end of the cord to a grounded ac outlet.

WARNING

The Model 175-AV is equipped with a 3-wire power cord that contains a separate ground wire and is designed to be used with grounded outlets. Failure to use a grounded outlet may result in personal injury or death because of electric shock.

CAUTION

Be sure that the power line voltage agrees with the indicated range on the rear panel of the instrument. Failure to observe this precaution may result in instrument damage.

2.3.2 Battery Pack Power

The Model 175-AV may also be operated from rechargeable sealed nickel-cadmium batteries contained in the optional Model 1758 Rechargeable Battery Pack. The battery pack will operate the Model 175-AV for up to six hours. The BAT annunciator will turn on when the battery charge is insufficient to maintain accurate readings. Refer to Section 5, paragraph 5.7 for installation and removal procedures.

2.3.3 Battery Charging

The Model 1758 Battery Pack in the Model 175-AV can be charged and recharged as follows:

1. Connect the instrument to line power as described in paragraph 2.3.1.
2. With the power switch off, the battery charge circuitry is automatically energized to charge the battery at the maximum rate. When the battery pack is first installed, or if it is completely discharged, allow it to charge for ten hours.

NOTE

For maximum battery efficiency, only charge the battery pack after it has become discharged and only charge until it is fully charged (≈10 hours). Continuous charging over long periods of time will not damage the batteries but useful life will gradually decrease. This loss is not permanent and may be restored by cycling the battery pack through several complete charge/discharge cycles. The battery pack is capable of 500 to 1000 charge/discharge cycles before replacement is needed. Do not make measurements with the BAT annunciator on as the readings may be erroneous.

3. When the Model 175-AV is in use on line power, the battery charger maintains a trickle charge on the battery pack.

2.4 FRONT PANEL FAMILIARIZATION

The following paragraphs and Figure 2-1 provide a brief description of the display, front panel controls, and input terminals.

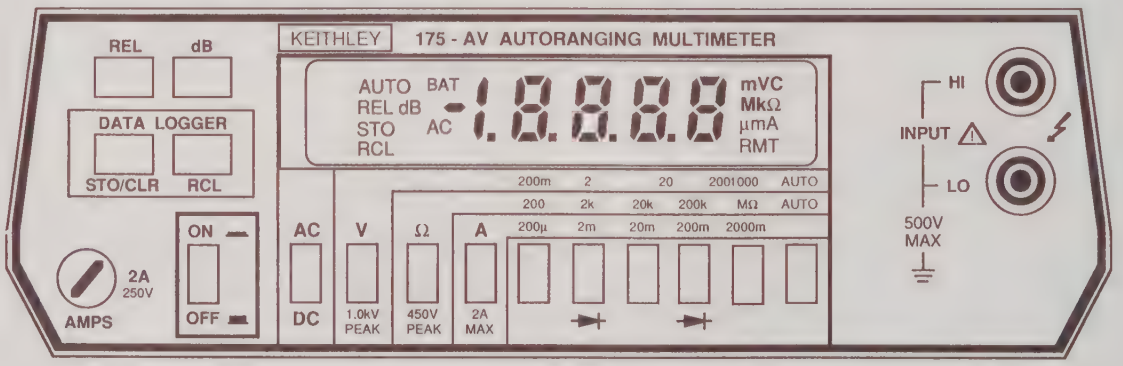


Figure 2-1. Model 175-AV Front Panel

2.4.1 Display

The Model 175-AV has a 4-1/2 digit liquid crystal display (LCD). The minus sign is displayed. The plus sign is implied by the absence of the minus sign. The following annunciators are displayed on the LCD.

BAT — Low battery indicator for the Model 1758.

AC — Ac selected (dc implied by absence of AC annunciator).

mV or V — Millivolts or volts selected.

Ω, kΩ, or MΩ — Ohms, kilohms, or megohms selected.

μ, mA, or A – Microamps, milliamps, or amps selected.

RMT (Remote) — Model 175-AV being controlled over the IEEE-488 bus (Model 1753-AV installed).

C — Model 175-AV in calibration mode.

AUTO — Autorange selected.

REL — Relative selected.

dB — Decibel selected.

STO — Data being stored.

RCL — Data being recalled. RCL flashes when buffer is full during logging cycle.

2.4.2 Front Panel Controls

ON/OFF — Pressing in this pushbutton turns the Model 175-AV on. Releasing (out) this pushbutton turns the instrument off.

REL (Relative) — This pushbutton allows readings to be made with respect to any baseline value. Also allows zeroing of on range readings. See paragraph 2.7.2 for more detailed information on REL.

dB — This pushbutton selects the dB function and is used along with the acV or dcV function. Measurements are made in dBm referenced to 600Ω. REL can be used to make any voltage level the 0dB reference point for dB measurements.

DATA LOGGER — Has min/max and 100-point reading storage capacity; records data at one of six selectable rates from 3 rdg/sec to 1 rdg/hr. Readings for minimum and maximum are sampled at the rate of 3 per second regardless of the selected rate.

1. STO/CLR — Pressing this button initiates the logging sequence. Pressing the button a second time shuts off the data logger.
2. RCL — Pressing and holding this button in scrolls the data pointer. To read the data at a particular point, simply release the button.

AC/DC — This switch is used along with the volts (V), current (A), and dB functions. Depressing (in) this pushbutton selects ac and releasing (out) this pushbutton selects dc.

V — Depressing this pushbutton selects the volts function.

Ω — Depressing this pushbutton selects the ohms function. The AC/DC pushbutton must be released (out).

A — Depressing this pushbutton selects the current function.

Range Push Buttons

1. AUTO — Depressing this pushbutton causes volts and ohms to autorange (no autoranging in current).
2. Manual ranging is accomplished by depressing the appropriate range button.

2.4.3 Input Terminals

The input terminals are intended to be used with safety shrouded test leads to help minimize the possibility of contact with live circuits. Safety shrouded test leads are supplied with the Model 175-AV.

INPUT HI and LO (Red and Black) — Use this pair of terminals for all volt, ohm, milliamp, and dB measurements.

2.4.4 AMPS Fuse Replacement

The AMPS fuse protects the current ranges from an input greater than 2A. See paragraph 5.3 for fuse replacement procedures.

Table 2-1. Error Messages

Display	Message	Comments
0000	RAM Error	Model 175-AV locks up. See Section 5 for troubleshooting information.
cErr	Calibration Error (NVRAM Failure)	Model 175-AV locks up, but operation can be restored by pressing any one of the four momentary pushbuttons. If restored, calibration is invalid as indicated by the flashing "C" annunciator. See Section 5 for troubleshooting information.
OL	Overrange	Overrange input applied to the Model 175-AV. Leading minus sign indicates that input signal has a negative value.
AC Err Ω	Invalid Ω Function	"AC" and "Ω" annunciators flash. Correct problem by releasing (out) AC/DC pushbutton.
Err A	Invalid A Range	"A" annunciator flashes. Correct problem by releasing (out) AUTO pushbutton.

2.5 ERROR MESSAGES

Table 2-1 lists the error messages associated with basic front panel operation. Note that the instrument has a number of other messages that are discussed in the appropriate sections of this manual.

2.6 OPERATING CONDITIONS

2.6.1 Environmental Conditions

All measurements should be made at an ambient temperature within the range of 0°C to 50°C, and with a relative humidity of 0% to 80% up to 35°C. For instruments above 35°C derate humidity 3% per °C up to 50°C. If the instrument has been subjected to extremes of temperature, allow sufficient time for internal temperatures to reach environmental conditions. Typically, it takes one hour to stabilize a unit that is 10°C (18°F) out of specified temperature range.

2.6.2 Maximum Allowable Inputs

Table 2-2 lists the maximum allowable inputs for the Model 175-AV.

2.7 BASIC BENCH MEASUREMENTS

Basic measurement techniques for using the Model 175-AV to measure ac and dc volts, resistance, ac and dc current, and dB are covered in the following paragraphs. Also included is the operation of the MIN/MAX and 100-point data logger.

WARNING

Before operating the Model 175-AV, observe the safety precautions found preceding Section 1. When testing high energy power circuits follow the procedure found in paragraph 2.2, High Energy Circuit Safety Precautions. Failure to observe these and other safety precautions found in this manual could result in severe injury or death.

Table 2-2. Model 175-AV Maximum Allowable Inputs

Function	Ranges	Maximum Allowable Inputs
dc Volts	200mV, 2V	1000Vdc or peak ac for less than 10sec per minute. 300Vrms continuous.
	20-1000V	1000Vdc or peak ac.
ac Volts	200mV	750Vrms, 1000V peak for less than 10sec per minute. 300Vrms continuous. 10^7V•Hz maximum.
	2-750V	750Vrms, 1000V peak. 10^7V•Hz maximum.
dc and ac Current	200µ-2000mA	2A, 250Vdc or rms (fuse protected).
Ω	All	450Vdc or peak ac

The INPUT LO terminal on the Model 175-AV is designed to float above earth ground to avoid ground loop problems.

WARNING

Hazardous voltages may be applied to the INPUT LO terminal. The maximum allowable voltage between INPUT LO terminal and chassis ground is 500V. Destruction of insulation, which could present a shock hazard, may occur if the 500V maximum is exceeded.

CAUTION

Do not exceed the maximum input limits shown in Table 2-2.

2.7.1 Power-Up

NOTE

The software revision level of the Model 175-AV can be displayed upon power-up by running the diagnostic program. See Section 5, Maintenance, for more information.

Turn on the Model 175-AV by pressing in the ON/OFF switch. The following will occur:

1. Reset — All zeros will be briefly displayed before going into the measurement mode.
2. RAM Test — If this test fails the Model 175-AV will lock up with zeros displayed.
3. NVRAM Test — If this test fails the display will show the error message "cErr".

Refer to Table 2-1 for more information pertaining to error messages.

2.7.2 Relative Mode

When the relative mode is selected with an on-scale reading on the display the following occurs:

1. The REL annunciator is displayed.
2. The next reading is stored.
3. The stored reading is then algebraically subtracted from all subsequent readings and displayed.

A REL level can be established for any measurement function (Volts, Ohms, Amps, and dB) and is effective only on that function. Changing functions will not affect a REL level already established. However, if another REL level is set (on any function), the previous REL level will be cancelled.

For example, place the 175-AV in the Ω function and select the 200Ω range. Short the test leads and press the REL button. Note that the REL annunciator is on. Select dcV and note that the REL annunciator is off, indicating that there is not a REL level established for dcV. Switch back to Ω and note that the REL level is still there. Again, go to dcV and set a REL level of +1V. The REL annunciator will

go on. Switch back to Ω and note that the REL annunciator is off, indicating that the REL level for Ω is cancelled.

Once a REL level is established for a measurement function, that stored level will be the same regardless of what range the Model 175-AV is on. For example, if +1V is established as the REL level on the 20Vdc range, +1V will also be the REL level on the 1000Vdc range.

It is important to note that the use of REL reduces the dynamic range of measurements by that level. For instance, assume that the REL level is +1V and the Model 175-AV is manually set to the 2V range. The maximum positive displayed reading, before overranging, would be +0.9999V. This is because the A/D converter would be seeing 1.9999V (maximum) from the input. Thus, the dynamic range of measurement is –1.9999V to +0.9999V (2.9998V) as compared to the normal –1.9999V to +1.9999V (3.9998V). The dynamic range of measurement has been reduced by 1V. The effects on dynamic range can be reduced by selecting a higher range or using autorange.

2.7.3 Dc Voltage Measurements

The Model 175-AV can make dc voltage measurements between 10μV and 1000V. The basic procedure is as follows:

1. Connect the test leads to the INPUT HI and LO terminals of the Model 175-AV.
2. Select the dcV function.
3. Select a range consistent with the expected voltage. For automatic range selection, press in the AUTO pushbutton.

NOTE
Manual ranging is recommended for routine measurements above 200V.

4. Connect the test leads to the source as shown in Figure 2-2. If the positive source terminal is connected to the INPUT LO terminal of the instrument, the display will show a negative value. If the negative source terminal is connected to the INPUT LO terminal, the display will show a positive value.
5. Observe the display; if the "OL" message is shown, select a higher range until a normal reading is shown. Always use the lowest possible range for the best resolution.
6. Take the reading from the display.

NOTE
High input impedance (>1000MΩ dc volts measurements can be made on the 200mV and 2V ranges by releasing (out) all the function pushbuttons (AC/DC, V, Ω, A).

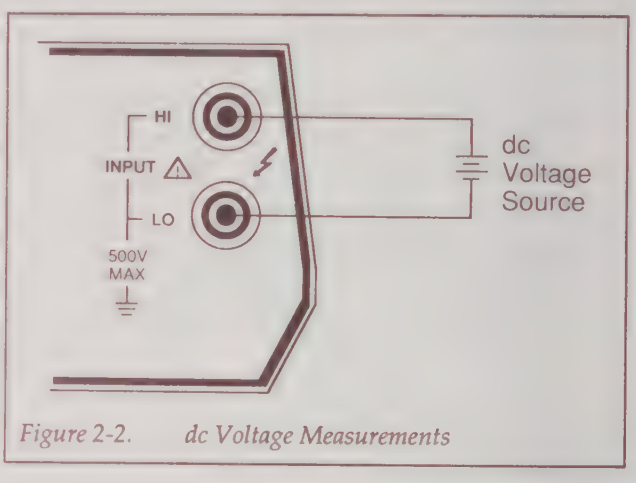


Figure 2-2. dc Voltage Measurements

2.7.4 Average Ac Voltage Measurements

The Model 175-AV can make ac voltage measurements between 10μV and 750V. Proceed as follows:

1. Connect the test leads to the INPUT HI and LO terminals of the Model 175-AV.
2. Select the acV function.
3. Select a range consistent with the expected voltage. For automatic range selection, press in the AUTO pushbutton.

NOTE
Manual ranging is recommended for routine measurements above 200V.

4. Connect the test leads to the source as shown in Figure 2-3.
5. Observe the display; if the "OL" message is shown, select a higher range until a normal reading is shown. Always use the lowest possible range for the best resolution.
6. Take the reading from the display.

NOTE
See paragraph 2.8 for average responding ac considerations.

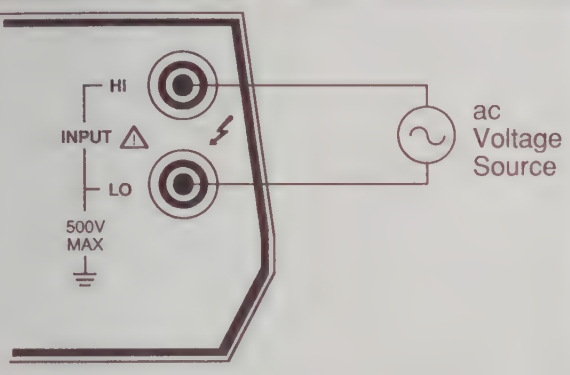


Figure 2-3. ac Voltage Measurements

2.7.5 Resistance Measurements

The Model 175-AV can make resistance measurements between 10mΩ and 200MΩ. The 2MΩ, 20MΩ, and 200MΩ ranges will autorange when the MΩ pushbutton is pressed in. Proceed as follows to make resistance measurements:

1. Connect the test leads to the INPUT HI and LO terminals of the Model 175-AV.
2. Select the Ω function.

NOTE
The message "Err" and flashing Ω and AC annunciators will be displayed if the AC/DC pushbutton is pressed in. This is an invalid mode. To correct, simply release (out) the AC/DC pushbutton.

3. Select a range consistent with the expected resistance. For automatic range selection, use the autorange mode.

NOTE
Zeroing may be necessary to compensate for test lead resistance on the 200Ω and 2kΩ ranges. Zero the display as follows:

A. Short the test leads together.
B. Press the REL pushbutton. The display will zero.
C. Proceed to step 4.

4. Connect the test leads to the resistance to be measured as shown in Figure 2-4.
5. Observe the display; if the "OL" message reading is shown, select a higher range until a normal reading is shown. Always use the lowest possible range for the best resolution.
6. Take the reading from the display.

NOTE
It is helpful to shield resistances greater than 10^6Ω (1MΩ) if a stable reading is expected. Place the resistance in a shielded enclosure and electrically connect the shield to INPUT LO of the Model 175-AV.

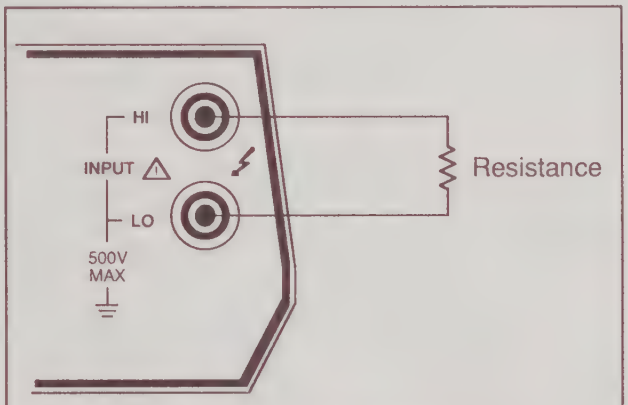


Figure 2-4. Resistance Measurements

2.7.6 Current Measurements (dc or average ac)

The Model 175-AV can make dc or ac current measurements between 10nA and 2A.

NOTE
For routine measurements above 2A it is recommended that the Model 1651, 50-Ampere current shunt be used.

For current measurements up to 2000mA:

1. Connect the test leads to the INPUT HI and LO terminals of the Model 175-AV.
2. Select the acA or dcA function.
3. Select an appropriate range for the expected current. Current measurements cannot autorange.
4. Connect the test leads to the current source as shown in Figure 2-5. If an overrange indication is displayed,

select a higher range until a normal reading is shown. Use the lowest possible range for the best accuracy.

5. Make the reading from the display.

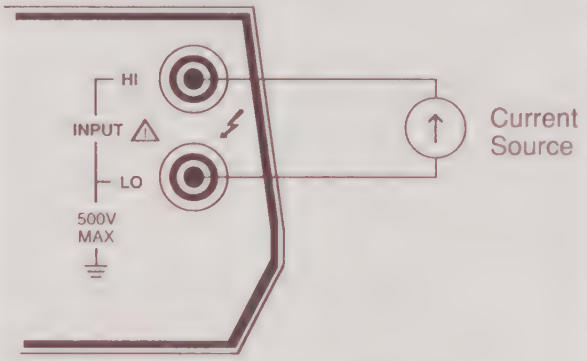


Figure 2-5. Current Measurements

2.7.7 dB Measurements

The dB function makes it possible to compress a large range of readings into a much smaller scope. The relationship between dB and voltage can be expressed by the following equation.

$$dB = 20 \log \frac{V_{OUT}}{V_{REF}}$$

Tables 2-3 and 2-4 list the dB specifications for dc volts and ac volts.

Table 2-3. dB Specifications for dc Volts (600Ω Ref).

Linear Counts	Resolution	Accuracy
10 – 99	1 dBm	±1 dBm
100 – 999	0.1 dBm	±0.1 dBm
1000 – 20000	0.01 dBm	±0.02 dBm

Table 2-4. dB Specifications for ac Volts (600Ω Ref)

dB Mode (ref: 600Ω)		Accuracy (± dBm)			
Range	Input	20Hz-10kHz	10kHz-20kHz	20kHz-50kHz	50kHz-100kHz
200mV	1mV to 2mV (–58 to –52dBm)	2*	—	—	—
	2mV to 20mV (–52 to –32dBm)	2	3	—	—
	20mV to 200mV (–32 to –12dBm)	0.2	0.3	1	—
2V-750V	200mV to 750V (–12 to +59.8dBm)	0.2	0.26	0.56	1.2

*Up to 1kHz

The Model 175-AV can make dBm measurements referenced to the standard 600Ω impedance or to other impedances. The relative feature allows measurements in dB independent of impedance.

The basic procedure for placing the instrument in the dB mode is to first select ac or dc volts and then press the dB button. Note that once dB is selected (dB annunciator on) pressing in the Ω or A function pushbuttons will turn dB off.

dBm Measurements with 600Ω Reference Impedance

dBm is defined as decibels above or below a 1mW reference. The standard reference impedance of the Model 175-AV is 600Ω. What this means is that the Model 175-AV is designed to read 0dBm when the calculated voltage needed to dissipate 1mW through a 600Ω impedance is applied to the Model 175-AV. That calculated voltage level is 0.7746V as derived from the basic power equation.

$$E = \sqrt{P \bullet R}$$
$$E = \sqrt{10^{-3}W \bullet 600\Omega}$$
$$E = 0.7746V$$

Thus, with a 600Ω reference impedance the Model 175-AV will read 0dBm whenever 0.7746V is applied.

NOTE

Do not confuse reference impedance with input impedance. The input impedance of the instrument is still 10MΩ (see specifications) in the dB mode.

To make dBm measurements referenced to 600Ω, proceed as follows:

1. Connect the test leads to the INPUT HI and LO terminals of the Model 175-AV.
2. Select the acV or dcV function.
3. Select autorange for optimum resolution.
4. Press the dB button.
5. Connect the test leads to the voltage source.
6. Make the dBm reading from the display.

dBm Measurements with Other Reference Impedances

dBm measurements can be made with other reference impedances. The most convenient method for using other reference impedances is to algebraically subtract the calculated dB offset for the desired reference impedance from the reading on the display of the Model 175-AV. Table 2-5 lists common reference impedances and the corresponding offset values. The following equation can be used to calculate the offset for impedances not listed in Table 2-5:

$$\text{Offset (for dBm)} = 10\log\frac{\text{New ref Z}}{600\Omega}$$

Table 2-5. Levels for Other Reference Impedances

Reference Impedance (Ω)	Equiv. Voltage Level for: 0dBm	0dBW	Offset (600Ω Ref) 0dBm	0dBW
8	0.0894	2.828	–18.75	11.25
50	0.2236		–10.79	
75	0.2739		–9.03	
150	0.3873		–6.02	
300	0.5477		–3.01	
600	0.7746		0.00	
1000	1.0000		2.22	

$$V_{equiv.} \text{ for 0dBm} = \sqrt{10^{-3}W \bullet Z_{REF}}$$
$$V_{equiv.} \text{ for 0dBW} = \sqrt{Z_{REF}}$$
$$\text{Offset (for dBm)} = 10 \log \left(\frac{Z_{REF}}{600\Omega}\right)$$
$$\text{Offset (for dBW)} = 10 \log \left(\frac{Z_{REF}}{600\Omega \bullet .001}\right)$$

To make dBm measurements referenced to another impedance, proceed as follows:

1. Choose the desired reference impedance.
2. Calculate or look up the offset value in Table 2-5 for the desired reference impedance.
3. Determine dBm at the desired reference impedance as follows:

dBm (at ref Z) = (175-AV reading) – offset

For example, when making dBm measurements referenced to a 100Ω reference impedance, the offset is calculated as follows:

$$\text{Offset} = 10 \log \frac{100\Omega}{600\Omega} = -7.78\text{dB}$$

This offset value must be subtracted from all subsequent displayed readings on the Model 175-AV.

dBm measurements, referenced to another impedance, can be read directly from the display of the Model 175-AV by using the REL feature, and an accurate voltage source. The basic procedure is as follows:

- Calculate or look up the equivalent voltage level (Table 2-5) for 0dBm at the desired reference impedance.
- Input that voltage level to the Model 175-AV.
- With the Model 175-AV in the dB mode, press the REL button.
- dBm measurements referenced to the desired impedance can now be read directly from the display of the Model 175-AV.

dBW Measurements

dBW is defined as decibels above or below a one watt reference. The procedure is the same as that found in paragraph 2.7.7 under dBm Measurements with Other Reference Impedances. The only difference is that the reference point is 0dBW (1W) rather than 0dBm (1mW).

dBV Measurements

dBV is defined as decibels above or below 1V (0dBV point). This is a voltage relationship independent of impedance. The basic procedure is to simply subtract 2.22dB (Table 2-5) from all subsequent displayed readings on the Model 175-AV.

Relative dB Measurements

Just about any voltage level within the measurement limits of the Model 175-AV can be established as the 0dB point. The basic procedure is to establish that level as the 0dB point by using REL and make the desired dB measurements.

2.7.8 dB Measurement Considerations and Applications

Typical Instrument Performance

Typically, the Model 175-AV will perform better than its published dB specification. The following example will illustrate this point:

1. Using the Model 175-AV in the dB mode (600Ω ref), measure a 1mV rms, 1kHz source (common application in the communications field). Typically, the Model 175-AV will read –57.7dBm.
2. The calculated dBm level for that source is –57.8dBm.
3. The 0.1dBm error is considerably better than the +2dBm specification. The specifications are intended to cover worst measurement conditions.

Measuring Circuit Gain/ Loss

Any point in a circuit can be established as the 0dB point. Measurements in that circuit are then referenced to that point expressed in terms of gain (+dB) or loss (–dB). To set the 0dB point:

1. Place the Model 175-AV in volts, autorange, and dB.
2. Connect the Model 175-AV to the desired location in the circuit.
3. Press the REL button. The display will read 0dB.
4. Gain/loss measurements can now be made referenced to the 0dB point.

Measuring Bandwidth

The Model 175-AV can be used to determine the bandwidth of an amplifier as follows:

1. Connect a signal generator to the input of the amplifier.
2. Set the Model 175-AV to acV and autorange.
3. Connect the DMM and a frequency counter to the load of the amplifier.
4. Adjust the frequency of the signal generator (<300kHz) until a peak ac voltage reading is measured on the Model 175-AV.
5. Press the dB button and then press the REL button. The 0dB point is now established.
6. Increase the frequency input until the Model 175-AV reads –3.00dB. The frequency measured on the frequency counter is the high end limit of the bandwidth.
7. Decrease the frequency input until the dB reading again falls to –3dB. The frequency measured on the

signal generator is the low end limit of the bandwidth.

Determining Q

The Q of a tuned circuit can be determined as follows:

1. Determine the center frequency and bandwidth as explained in paragraph 2.7.8, Measuring Bandwidth.
2. Calculate Q by using the following formula:

Q = Center Frequency / Bandwidth

2.7.9 MIN/MAX and 100-Point Data Logger Operation

The data logger can store up to 100 readings and store the minimum and maximum readings recorded during the period that the data logger is active. The data logger remains active even after 100 points of data are stored, which means the MIN/MAX readings continue to update. The only way to deactivate the data logger is to press the STO/CLR button (STO annunciator off) or cycle power.

The 100 points of data are stored at one of six selectable rates from three per second to one reading per hour. Readings for minimum and maximum are sampled at the rate of three per second regardless of the selected rate. The procedure for operating the data logger is as follows:

1. Connect the desired measurement configuration to the Model 175-AV. Make sure that the controls of the Model 175-AV are set appropriately.
2. Logging data:
   A. Press and hold the STO/CLR pushbutton. The following reading rates will scroll on the display:

      r = 0 (every reading)
      r = 1 (1 rdg/sec)
      r = 2 (1rdg/10sec)
      r = 3 (1 rdg/min)
      r = 4 (1 rdg/10 min)
      r = 5 (1 rdg/hr)

   NOTE
   There is no need to select a rate if just minimum/maximum readings are desired. Momentarily press the STO/CLR button to start the logger.

   B. Release the STO/CLR pushbutton when the desired reading rate is displayed. The STO annunciator will turn on and data will be logged at the selected rate.

   NOTE
   The logging cycle can be terminated at any time by pressing the STO/CLR button. This shuts off the data logger. However, data is retained and can be recalled at any time as long as the instrument remains on.

3. Data retrieval — Data can be retrieved at any time, but a flashing RCL annunciator indicates that the maximum number of readings (100) has been stored.
   A. Press and hold in the RCL pushbutton. The display will scroll through the data points and MIN/MAX (LO/HI). The first data point displayed will be the last stored reading. The next two data points will be the HI and LO readings made during that logging cycle. Notice that the longer the RCL pushbutton is held in the faster the data points will scroll on the display.
   B. Release the RCL pushbutton at the desired data point and note the reading (data) on the display. The data pointer can be incremented by steps of one by momentarily holding in the RCL pushbutton.
4. Shut off the data logger by pressing the STO/CLR pushbutton. All stored data will be retained until a new store cycle has commenced.

2.7.10 Diode Test

The 2kΩ and 200kΩ ranges can be used for testing semiconductor junctions as follows:

1. Select Ω function.
2. Press 2k and 200k pushbuttons (diode symbols) in simultaneously.
3. Display reads forward V drop of diode at 0.7mA (up to 2V). Red terminal is positive.

2.8 AVERAGE RESPONDING MEASUREMENTS

Most DMMs, including the Model 175-AV, actually measure the average value of an input waveform but are calibrated to read its rms equivalent. This poses no problem as long as the waveform being measured is a pure, low-distortion sine wave. For complex, non-sinusodial

waveforms, however, measurements made with an averaging type meter can be inaccurate.

2.8.1 Waveform Comparison

The rms value of a pure sine wave is equal to 0.707 times its peak value. The average value of such a waveform is 0.637 times the peak value. Thus, for an average-responding meter, a correction factor must be designed in. This correction factor (K) can be found by dividing the rms value by the average value as follows:

$$K = \frac{0.707}{0.637} = 1.11$$

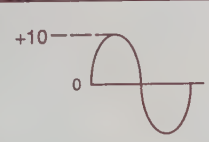
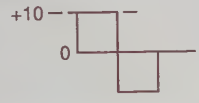
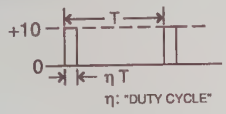
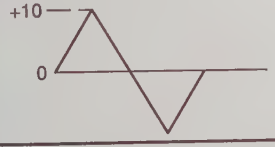
By applying this correction factor to an averaged reading, a typical meter can be designed to give the rms equivalent. This works fine as long as the waveform is a pure sine, but the ratios between the rms and average values of different waveforms can vary considerably.

Table 2-6 shows a comparison of common types of waveforms. For reference, the first waveform is an ordinary sine wave with a peak amplitude of 10V. The average value of the voltage is 6.37V, while its rms value is 7.07V. If we apply the 1.11 correction factor to the average reading, it can be seen that the average reading will equal the rms value, resulting in no error for an average-type meter reading.

The situation changes with the half-wave rectified sine wave. As before, the peak value of the waveform is 10V, but the average value drops to 3.18V. The rms value of this waveform is 5.00V, but an average responding meter will give a reading of 3.53V (3.18 × 1.11), creating an error of 29.4%.

A similar situation exists for the rectified square wave, which has an average value of 5V and an rms value of 5V. The average responding meter gives a reading of 5.55V (5 × 1.11). Other waveform comparisons can be found in Table 2-6.

Table 2-6. Average Responding Meter Readings for Various Waveforms

Waveform	Ac Coupled Peak Value	RMS Value	Average Responding Meter Reading	Averaging Meter Percent Error
Sine 	10V	7.07V	7.07V	0%
Half-Wave Rectified Sine	10V	5.00V	3.53V	29.4%
Full-Wave Rectified Sine	10V	7.07V	7.07V	0%
Square 	10V	10.00V	11.10V	11%
Rectified Square Wave	10V	5.00V	5.55V	11%
Rectangular Pulse 	10V	10V $\bullet\sqrt{\eta}$	11.1V $\bullet\ \eta$	$(1.11\sqrt{\eta} - 1) \times 100\%$
Triangular Sawtooth 	10V	5.77V	5.55V	3.8%

2.8.2 Ac Voltage Offset

Typically the Model 175-AV will display 25 counts or less of offset on ac volts with the input shorted. This offset is caused by amplifier noise and offset of the rms-to-dc converter. This offset will not affect reading accuracy and should not be zeroed out using the REL feature. The following equation expresses how this offset (V_{OFFSET}) is added to the signal input (V_{IN}):

$$\text{Displayed Reading} = \sqrt{(V_{IN})^2 + (V_{OFFSET})^2}$$

As long as V_{IN} is at least 10 times larger than V_{OFFSET}, negligible error will occur.

Example: Range = 2Vac
Offset = 25 counts
Input = 200mV rms

$$\begin{aligned}\text{Displayed Reading} &= \sqrt{(0.2)^2 + (.0025)^2} \\ &= \sqrt{0.04 + 0.0000063} \\ &= \sqrt{0.0400063} \\ &= .2000\text{V rms}\end{aligned}$$

If REL is used to zero the display, the 25 counts of offset would be subtracted from V_{IN}, resulting in an error of 25 counts in the displayed reading.

2.8.3 Extended Frequency Response

Figure 2-6 illustrates the extended frequency response of the ac voltage ranges up to 1MHz.

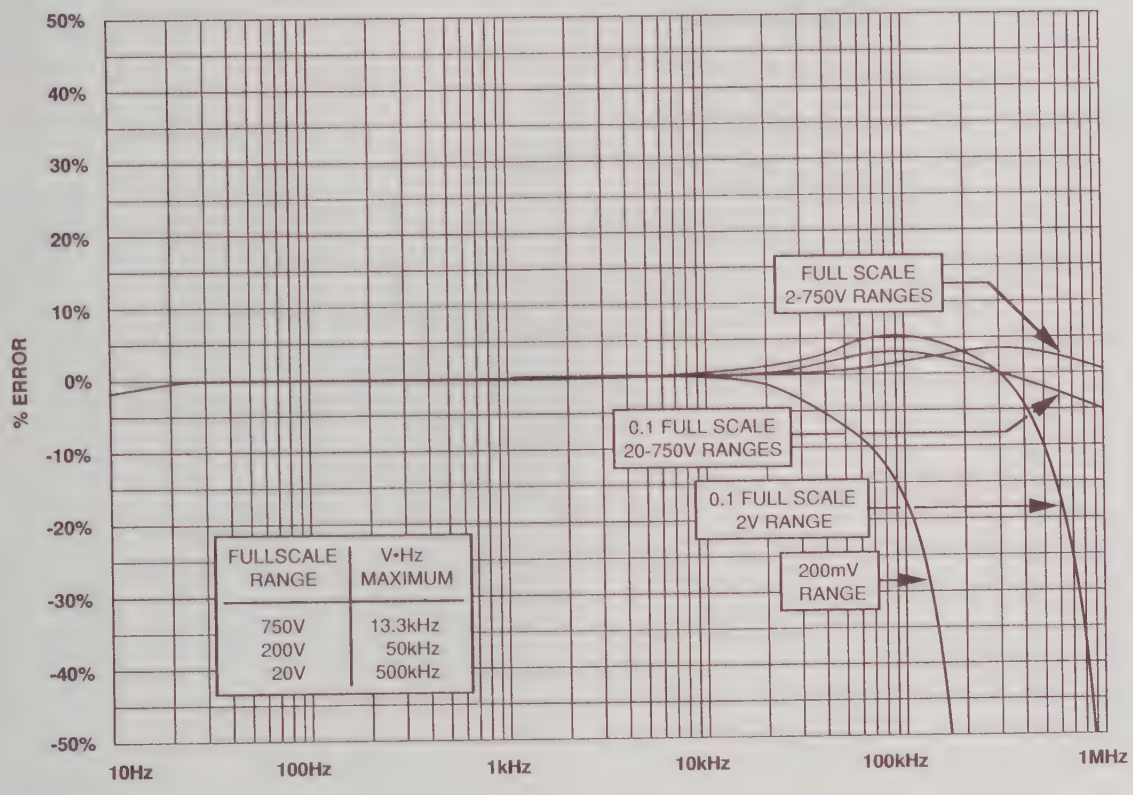


Figure 2-6. Model 175-AV Typical acV Frequency Response

SECTION 3
Performance Verification

3.1 INTRODUCTION

The procedures outlined in this section may be used to verify that the instrument is operating within the limits stated in the specifications at the front of this manual. Performance verification may be done when the instrument is first received to ensure that no damage or misadjustment has occurred during shipment. Verification may also be performed whenever there is a question of instrument accuracy, or following calibration, if desired.

NOTE

If the instrument is still under warranty (less than one year from the date of shipment), and its performance falls outside the specified range, contact your Keithley representative or the factory to determine the correct course of action.

3.2 ENVIRONMENTAL CONDITIONS

All measurements should be made at 18-28°C (65-82°F) and at less than 80% relative humidity.

3.3 INITIAL CONDITIONS

The Model 175-AV must be turned on and allowed to warm up for at least one hour before beginning the verification procedures. The instrument may be operated from either line power or battery pack power, as long as the battery pack has been fully charged as described in paragraph 2.3.3.

If the instrument has been subject to extremes of temperature (outside the range specified in paragraph 3.2), additional time should be allowed for internal temperatures to reach normal operating temperature. Typically, it takes one additional hour to stabilize a unit that is 10°C (18°F) outside the specified temperature range.

3.4 RECOMMENDED TEST EQUIPMENT

Table 3-1 lists all test equipment required for verification. Alternate equipment may be used as long as the substitute equipment has specifications at least as good as those listed in the table.

NOTE

The verification limits in this section do not include test equipment tolerance.

3.5 VERIFICATION PROCEDURE

The following paragraphs contain procedures for verifying the specifications of the instrument for each of its five measuring functions: dc volts, average ac volts, ohms, dc amps, and average ac amps. These procedures are intended for use only by qualified personnel using accurate and reliable test equipment. If the unit is out of specifications and not under warranty, refer to Section 5 for calibration procedures.

WARNING

The maximum common-mode voltage (voltage between input low and chassis ground) is 500V peak. Exceeding this value may cause a shock hazard. Some of the procedures in this section may expose the user to dangerous voltages. Use standard safety precautions when such dangerous voltages are encountered.

3.5.1 Dc Voltage Verification

CAUTION

Do not exceed 1000V between the INPUT HI and LO terminals or damage to the instrument may occur.

1. Select the dcV function and 200mV range.
2. Connect the calibrator to the instrument.
3. Apply +100.000mVdc to the Model 175-AV. The reading must be within the limits specified in Table 3-2.

Table 3-1. Recommended Test Equipment

Manufacturer	Model	Description	Specifications
Fluke	5101B	dc Voltage Calibrator	200mV, 2V, 20V, 200V, 1000V ranges, ±0.005%
		ac Voltage Calibrator	200mV, 2V, 20V, 100V, 50Hz to 10kHz, ±0.05%
		Resistance Calibrator	100Ω, 1kΩ, 10kΩ, 100kΩ ranges, ±0.005%; 1MΩ range ±0.01%; 10MΩ range, ±0.05%
		dc Current Calibrator	200µA, 2mA, 20mA, 200mA, 2000mA ranges, ±0.025%
Fluke	5200A	ac Voltage Calibrator	100mV, 1V, 10V, 100V ranges; 20Hz-50Hz, ±0.1%; 20kHz-100kHz, ±0.05%
Fluke	5205A	Power Amplifier	1000V range; 10Hz-30Hz, ±0.12%; 50kHz-100kHz, ±0.10%

4. For each remaining range, apply the required voltage as specified in Table 3-2, and verify that the reading is within specifications.
5. Repeat all checks with negative voltage.

Table 3-2. Limits for dc Voltage Verification

dcV Range	Applied dc Voltage	Allowable Readings (18° C to 28° C)
200 mV	100.000 mV	99.94 to 100.06
2 V	1.00000 V	0.9995 to 1.0005
20 V	10.0000 V	9.995 to 10.005
200 V	100.000 V	99.95 to 100.05
1000 V	1000.00 V	999.5 to 1000.5

3.5.2 Average Ac Voltage Verification

CAUTION

Do not exceed 750V rms, 1000V peak 10^7V•Hz, between the INPUT HI and LO terminals or instrument damage may occur.

1. Select the acV function and 200mV range.
2. Connect the calibrator to the DMM.
3. Set the calibrator output to 100.000mV ac at a frequency of 20Hz. Verify that the reading is within the limits specified in Table 3-3.
4. Repeat the 100mV ac measurement at the other frequencies specified in Table 3-3.
5. Check the 2V, 20V, 200V, and 750V ranges by applying the required voltages and frequencies specified in Table 3-3 and verifying that the readings are within the specified limits.

Table 3-3. Limits for ac Voltage Verification

acV Range	Applied ac Voltage	Allowable Readings (18°C to 28°C)					
		20Hz	50Hz	10kHz	20kHz	50kHz	100kHz
200 mV	100.000 mV	98.80 to101.20	99.30 to100.70		98.10 to 101.90	91.25 to 108.75	—
2 V	1.00000 V	0.9880 to1.0120	0.9930 to1.0070		0.9860 to 1.0140	0.9675 to 1.0325	0.9300 to 1.0700
20 V	10.0000 V	9.880 to10.120	9.930 to10.070		9.860 to 10.140	9.675 to 10.325	9.300 to 10.700
200 V	100.000 V	98.80 to101.20	99.30 to100.70		98.60 to 101.40	96.75 to 103.25	93.00 to 107.00
750 V	750.00 V	740.5 to 759.5	744.2 to 755.8		—	—	—

3.5.3 Resistance Verification

CAUTION
Do not exceed 450Vdc or peak ac between the INPUT HI and LO terminals or instrument damage may occur.

1. Select the Ω function (AC/DC pushbutton must be out) and the 200Ω range.
2. Connect the test leads to the Model 175-AV and short the other ends together.
3. Press the REL pushbutton to compensate for the test lead resistance.
4. Disconnect the short and connect the test leads to the calibrator.
5. Set the calibrator to 100.000Ω and verify that the reading is within the limits specified in Table 3-4.
6. Check the 2kΩ, 20kΩ, 200kΩ, and MΩ ranges by applying the required resistances specified in Table 3-4 and verifying that the readings are within the specified limits.

Table 3-4. Limits for Resistance Verification

Ω Range	Applied Resistance	Allowable Readings (18°C to 28°C)
200 Ω	100.000 Ω	99.93 to 100.07
2 kΩ	1.00000 kΩ	0.9994 to 1.0006
20 kΩ	10.0000 kΩ	9.993 to 10.007
200 kΩ	100.000 kΩ	99.94 to 100.06
2MΩ	1.00000 MΩ	0.9993 to 1.0007
20MΩ	10.0000 MΩ	9.979 to 10.021

3.5.4 Dc Current Verification

CAUTION
Do not exceed 2A to the INPUT HI and LO terminals or the AMPS fuse will blow.

1. Select the dcA function and, initially, the 2000mA range.
2. Connect the calibrator to the INPUT HI and LO terminals of the Model 175-AV.
3. Apply 100.000μA and switch the Model 175-AV to the 200μA range. The reading must be within the limits specified in Table 3-5.
4. Check the 2mA through 2000mA ranges by applying the required current specified in Table 3-5 and verifying that the readings are within the specified limits.

Table 3-5. Limits for dc Current Verification

dcA Range	Applied dc Current	Allowable Readings (18°C to 28°C)
200 μA	100.000 μA	99.83 to 100.17
2 mA	1.00000 mA	0.9983 to 1.0017
20 mA	10.0000 mA	9.983 to 10.017
200 mA	100.000 mA	99.78 to 100.22
2000mA	1000.00 mA	997.8 to 1002.2

3.5.5 Average Ac Current Verification

Since ac current uses the same circuitry as ac volts and dc current already checked in paragraphs 3.5.2 and 3.5.4, no additional accuracy checks are necessary.

SECTION 4
Principles of Operation

4.1 INTRODUCTION

This section contains an overall functional description of the Model 175-AV. Information pertaining to the Model 1758 Battery Pack option is also included. Detailed schematics and component location drawings are at the end of this instruction manual.

4.2 OVERALL FUNCTIONAL DESCRIPTION

The Model 175-AV is a 4-1/2 digit, ±20,000 count DMM with five ac and dc voltage ranges, seven resistance ranges, and five ac and dc current ranges. A simplified block diagram of the Model 175-AV is shown in Figure 4-1. The heart of the Model 175-AV is the A/D converter that translates the conditioned analog input signals into a form usable by the microcomputer.

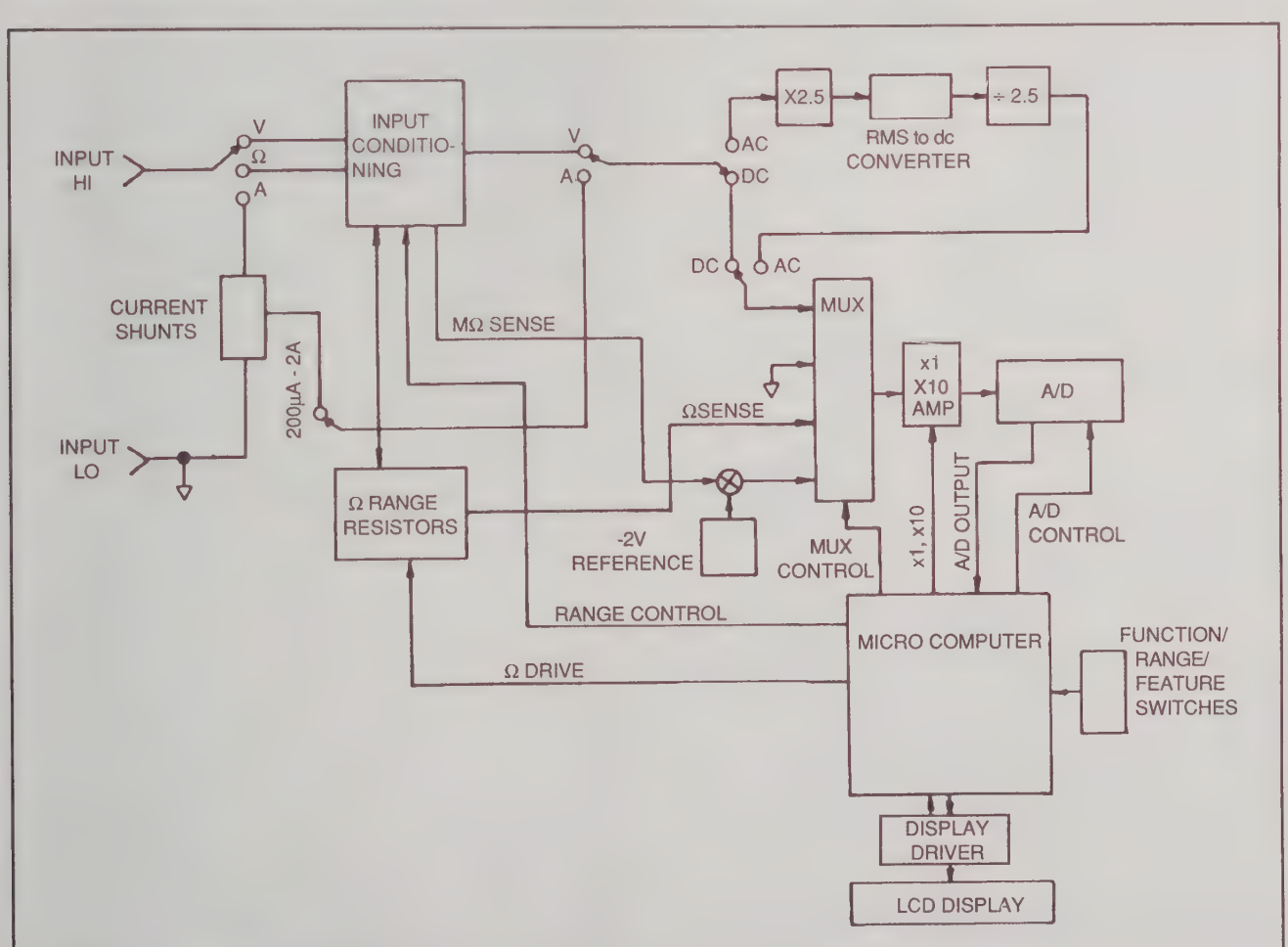


Figure 4-1. Simplified Block Diagram

4.3 ANALOG CIRCUITRY

The following paragraphs contain a description of the input multiplexer, buffer amplifier, –2V reference, and A/D converter circuits. These circuits may be found on schematic diagram number 175-AV-106 located at the end of this manual.

4.3.1 Multiplexer

The multiplexer connects one of four signals to the buffer amplifier: signal, zero, ohms reference, or reference. The multiplexer, shown in Figure 4-2, is made up of four JFETS, which are controlled by the microprocessor through U114. The FETs are driven by U109 and part of U106. The drivers convert the digital signals of the microprocessor to signals usable by the FETs.

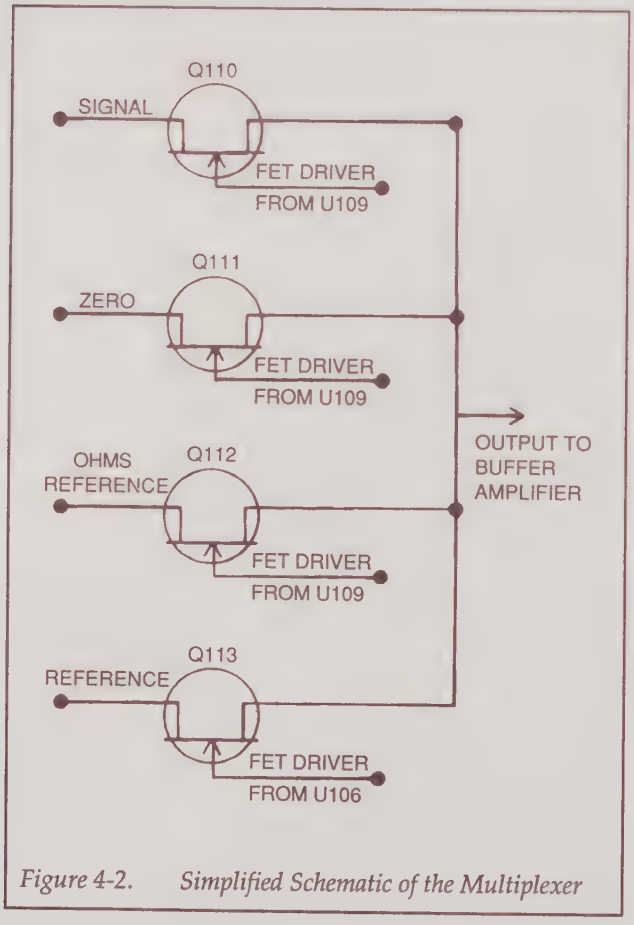


Figure 4-2. Simplified Schematic of the Multiplexer

Ordinarily, FET switching creates transients that could be seen in the final measurement. These effects are minimized in the Model 175-AV through the use of software generated delays and by shorting the multiplexer bus to signal common before each signal measurement through Q111.

4.3.2 Input Buffer Amplifier

The input buffer amplifier provides the necessary isolation between the input signal and the A/D converter. The amplifier is a non-inverting, low noise, high impedance circuit with ×1 or ×10 gain. The amplifier gain is controlled by the microprocessor and is range and function dependent. Figure 4-3 shows the simplified schematic of the input buffer amplifier.

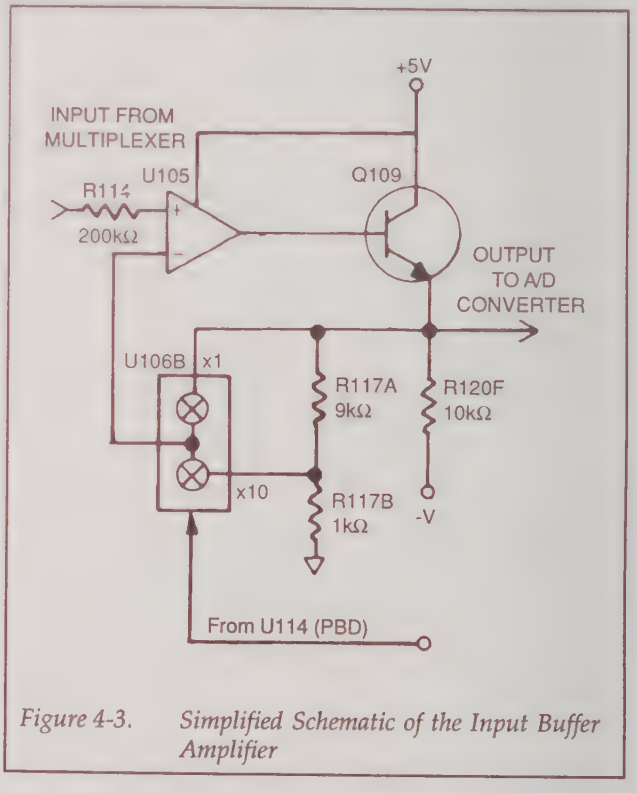


Figure 4-3. Simplified Schematic of the Input Buffer Amplifier

4.3.3 –2V Reference Source

The Model 175-AV voltage and current measurements are based on comparing the unknown signal with an internal –2V reference voltage. During each measurement cycle the microprocessor samples the unknown and uses it along with a zero measurement and –2V signal measurement to compute the unknown voltage.

The –2V reference is made up of a highly stable zener diode (VR101), an op-amp and a resistive voltage divider.

U103 and R120 A, B, C act as a constant current source to minimize the zener voltage variations. R117 C, D is then used to divide down the –6.35V zener voltage to –2V.

The output of U103 (–7V) is used as a reference voltage for the A/D converter and as a negative supply for various components.

4.3.4 A/D Converter

The Model 175-AV uses a combination constant frequency charge balance, single slope analog-to-digital converter. A simplified schematic of the A/D used in the Model 175-AV is shown in Figure 4-4 with an associated output waveform.

The charge balance phase begins when the input enable/$\overline{\text{disable}}$ line is set high. This occurs at the end of a software-generated delay period that allows the signal to settle after the appropriate multiplexer FET is turned on. The actual delay period depends on the selected range and function.

Once this occurs, the signal from the buffer amplifier is added to the offset from R120H. This converts the bipolar signal from the buffer (±2V) to a unipolar input to the integrator.

The integrator ramps up until it just passes the charge balance comparator threshold voltage. When the rising edge of Q3 occurs from U122 or when U119 goes low, $\overline{Q}$ goes high forcing I_{CB} into the integrator input. Since I_{CB} is much greater than the current through R120G and R120H, the integrator output voltage will ramp in the negative direction. The integrator will continue ramping downward until U119B goes low. Each time the output of U121A goes high, it is gated (inside the microprocessor) with the microprocessor's internal clock and these pulses are counted. Once U121A goes low the process repeats itself.

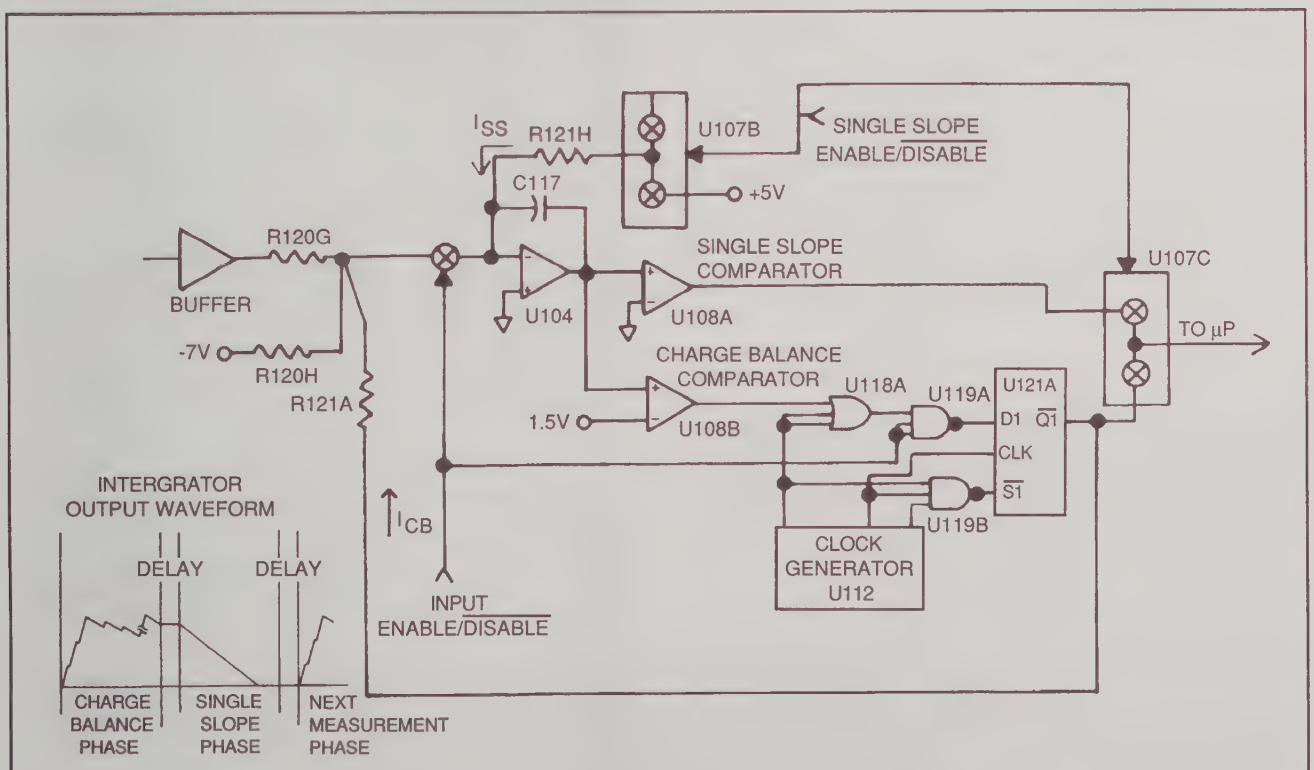


Figure 4-4. Simplified Schematic of the A/D Converter

The charge balance phase continues for 100msec. At the end of the charge balance phase, the output of the integrator is resting at some positive voltage. Since the integrator output is connected to the non-inverting input of U108A, its output will stay high until the integrator ramps negative. During single slope, Q114 is turned off and R121H is connected to +5V. The single slope comparator is then gated with the microprocessor's internal clock and counted. Once the comparator output goes low, the microprocessor stops counting and can compute the reading.

4.3.5 Input Signal Conditioning

For dcV and acV, the signal conditioning is performed by R106, its shunt capacitors, K101, K102, K103, and Q106.

The following attenuation is provided:

In the dcV mode:

÷1 is used on the 200mV and 2V ranges
÷10 is used on the 20V range
÷100 is used on the 200V range
÷1000 is used on the 1000V range

In the acV mode:

÷1 is used on the 200mV range
÷10 is used on the 2V range
÷100 is used on the 20V range
÷1000 is used on the 200V and 1000V range

Protection for the ac and dc voltage ranges is provided by R103, R108, Q107, and Q108. R103 and R108 are used exclusively on the lower ranges of acV and dcV to limit current to Q107 and Q108 during overload. During the overload, Q107 and Q108 clamp the maximum voltage on the signal FET line to within 0.7V of the supplies.

Signal conditioning for current is performed by R109 and R110 current shunts. For dc current measurements, the shunt voltage drop (200mV full scale) is applied directly to the input signal FET for conversion. In ac current, the shunt voltage drop is treated as a 200mV ac signal and is switched to the ac converter section. Overload clamping occurs at three diode voltage drops, which is a level high enough to permit high crest factor current waveforms.

In dcV, the properly scaled signal is applied directly to Q110 through R107 and C110. In the acV mode, the scaled analog signal is applied to the ac converter for transformation to a dc signal that is applied to Q110.

Resistance measurements are made using the ratiometric technique (see Figure 4-5). When the resistance function is selected, a series circuit is formed among the ohms source, reference resistor, and the external unknown resistance.

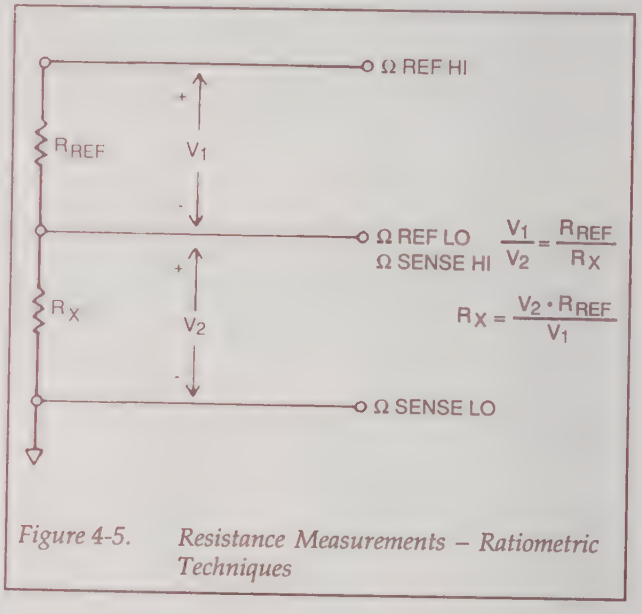


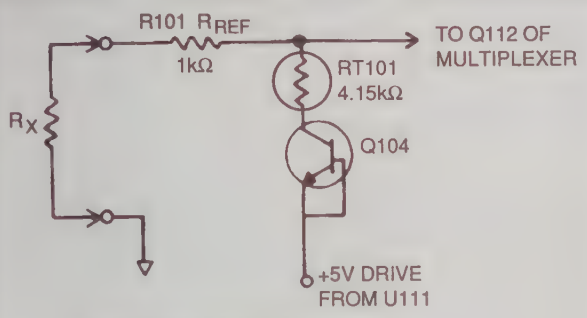
Figure 4-5. Resistance Measurements – Ratiometric Techniques

Three reference resistors are used on the ohms ranges: R101, R102, and R106A. R101 is used for the 200Ω and 2kΩ ranges, R102 for the 20kΩ and 200kΩ ranges, and R106A for 2MΩ, 20MΩ, and 200MΩ. Drive for the ohms ranges is ultimately controlled by the microprocessor through U111 and U112.

Switching for the ohms ranges is done using low leakage base to collector diodes of Q102, Q104, and Q105. The appropriate transistor is turned on by driving the base high (+5V). The simplified schematics for the ohms circuitry are shown in Figure 4-6.

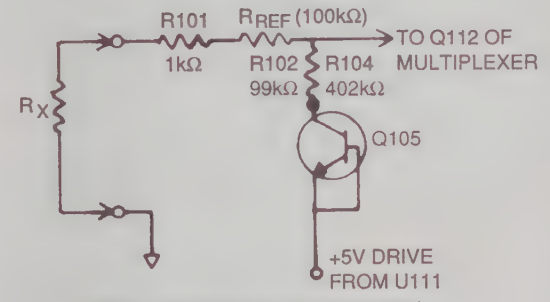
By measuring the four inputs to the A/D converter, the unknown resistance can be computed by the microprocessor using the equation:

$$R_X = \frac{\Omega\ \text{SENSE HI} - \Omega\ \text{SENSE LO}}{\Omega\ \text{REF HI} - \Omega\ \text{REF LO}}$$



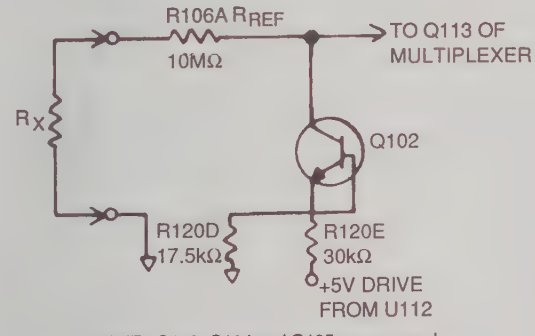
NOTE: Q102, Q103, &Q105 are reversed biased and functionally out of circuit.

A. 200Ω and 2kΩ Ranges



NOTE: Q102, Q103 & Q104 are reversed biased and functionally out of the circuit.

B. 20kΩ and 200kΩ Ranges



NOTE: Q103, Q104 and Q105 are reversed biased and functionally out of the circuit.

C. 2MΩ, 20MΩ and 200MΩ Ranges

Figure 4-6. Simplified Schematics of Ohms Circuitry

For the 200Ω, 20kΩ, 2MΩ ranges, Ω SENSE HI is actually multiplied by a factor of ten in the buffer circuit.

Protection on the ohms ranges is accomplished by Q103, RT101, Q101, R103, Q107, and Q108. For a voltage applied to the input terminals, Q101 clamps the voltage across R101 to a safe level. RT101 limits current to Q103, which clamps the voltage at Q104 to a safe limit (<12V).

For the 20kΩ and 200kΩ ranges, protection is provided by R102, R104, and R105. R106A provides protection for the 2MΩ, 20MΩ, and 200MΩ ranges by limiting current.

4.3.6 Ac Converter

All ac voltage inputs pass through U101 for a ×2.5 voltage amplification. The gain stage is used to permit accurate voltage measurement at higher frequencies and lower input levels.

The output of U101 is applied to the rms-to-dc converter chip (U102), which converts the ac input signal to the corresponding dc level. The dc output is then ÷2.5 and applied to the signal FET.

4.4 DIGITAL CIRCUITRY

Model 175-AV operation is controlled by the internal microcomputer. The following paragraphs briefly describe the operation of the various sections of the microcomputer and associated digital circuitry. A simplified block diagram is included for user reference; for more complete circuit details refer to schematic diagram number 175-AV-106 at the end of this manual.

4.4.1 Microcomputer

The microcomputer centers around the 146805E2 CMOS microprocessor. It is an 8-bit microprocessor with direct addressing of up to 8K bytes on a shared address and data bus.

Timing of the microprocessor is accomplished by the use of Y101, a 3.2768MHz crystal. Internally, this frequency is divided down by five to obtain a bus operating frequency of 655.36kHz. This is present on the address strobe of U123 (pin 6) and supplies timing to all other parts of the instrument through the binary divider U122.

The software for the microprocessor is stored in U115 (PROM). Temporary storage is provided by U113. U113

is used to share the calibration constants on power-up and as RAM for the microprocessor's in-house functions. It also stores readings for the data logger. U110 is the NVRAM and stores the calibration constants.

4.4.2 Address Decoding

U120 latches in the address that is on the bus when the address strobe of U123 goes high and presents it to the PROM (U115) during data strobe.

4.4.3 PIA

U114 provides for most of the control of the instrument. It controls all ranging hardware, A/D converter, and data output and input for the IEEE-488 option.

4.4.4 Display Board

The LCD display is driven by a flat pack LCD controller chip (U201), which communicates to the microprocessor through four control lines. During power-up, the microprocessor configures U201 to drive the triplexed display.

To drive the display correctly, four voltages are obtained from R126. The clock required by U201 is obtained from U122.

The display board also houses the special function keys: dB, REL, STO/CLR, and RCL.

4.5 DIGITAL CALIBRATION

The Model 175-AV uses digital calibration to eliminate all potentiometers in the instrument to facilitate calibration. The constants that the Model 175-AV uses are stored in a nonvolatile, electrically alterable, read-only memory (U110), and are read on power-up of the instrument. There is one constant for each range on dcV, acV, and Ω.

On the dcA and acA functions, the 200mV dc and 200mV ac constants are used respectively.

4.6 POWER SUPPLY

Fuse F102 is the line fuse, which is internally accessible. S101 is the power on/off switch and S102 selects 115V or 230V operation by placing the transformer primary windings in parallel or series.

T101, the power transformer, has two secondary windings: one for the Model 175-AV and the other for the IEEE-488 option (Model 1753-AV). The bridge rectifier (CR104) functions as a full-wave rectifier for both the plus and minus supplies. R123 limits current to the 12V zener (VR102) and to the batteries (if installed) for charging. The zener acts as a pre-regulator to the +5V regulator.

4.7 MODEL 1758 BATTERY OPTION

The maximum battery charging rate is achieved when the instrument is connected to line power and the on/off switch is off. Full-wave rectified voltage from CR104 is applied to R102 and BT101 to charge the batteries. Q101 acts as a current sink if the charging current rises above 150mA. The batteries are of the quick recharge type and will charge in 8 to 10 hours. With the instrument turned on, the batteries will trickle charge at approximately 40mA.

With the battery pack installed, the negative supply is generated using a CMOS voltage inverter (U101). The output of the inverter is applied to CR101 and C101 for filtering.

Low battery detection is done by the comparator (U102) and the microprocessor. A voltage level of 8.8V across BT101 signals the end of useful battery life. The trip level for the comparator is set by R103 and R104.

SECTION 5
Maintenance

5.1 INTRODUCTION

This section contains information necessary to maintain, calibrate, and troubleshoot the Model 175-AV. Line voltage selection, fuse replacement, and Model 1758 Battery Pack installation procedures are also included.

WARNING

The procedures included in this section are for use only by qualified service personnel. Do not perform these procedures unless qualified to do so. Many of the steps in this section may expose you to potentially lethal voltages that could result in personal injury or death if normal safety precautions are not observed.

5.2 LINE VOLTAGE SELECTION

The Model 175-AV may be operated from either 105-125V or 210-250V, 50 or 60Hz power sources. If the line voltage setting of the instrument needs to be changed, set the line voltage switch, located on the rear panel, in the desired position. (See Figure 5-1.)

WARNING

Disconnect the power cord and all other equipment from the Model 175-AV.

NOTE

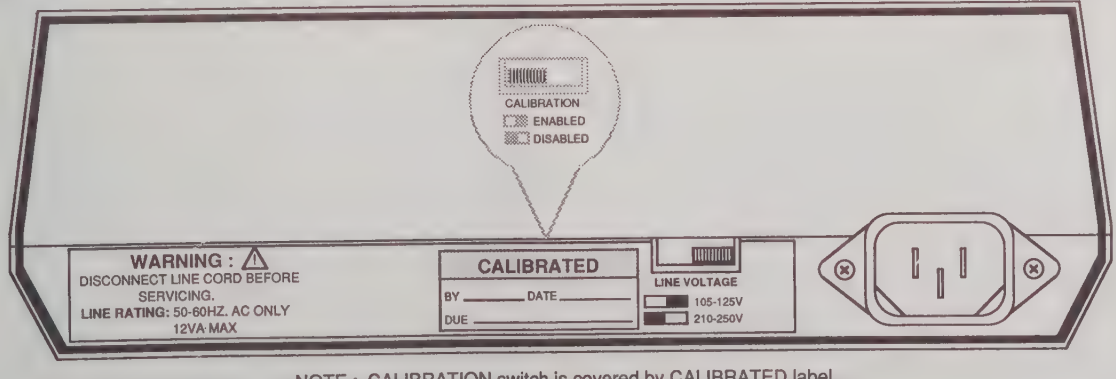
Although the Model 175-AV is specified at 50 and 60Hz, the instrument may be operated at 400Hz and 440Hz. Add one count to instrument specifications under this condition.

5.3 FUSE REPLACEMENT

The Model 175-AV has two fuses for protection in case of overload. The AMPS fuse protects the current function from excessive current, and the line fuse protects the line power input of the instrument. The fuses may be replaced by using the procedures found in the following paragraphs.

WARNING

Disconnect the instrument from the power line and from other equipment before replacing fuses.



NOTE : CALIBRATION switch is covered by CALIBRATED label

Figure 5-1. Model 175-AV Rear Panel

5.3.1 AMPS Fuse

The AMPS fuse protects the current ranges from an input greater than 2A. To replace the AMPS fuse, perform the following steps:

1. Turn off the power and disconnect the line cord and all test leads from the instrument.
2. Place the end of a flat-blade screwdriver into the slot in the fuse holder on the front panel. Press in slightly and rotate the fuse carrier one-quarter turn counter-clockwise. Release pressure and remove the fuse carrier and the fuse.
3. Remove the defective fuse and replace it using Table 5-1 as a guide.

CAUTION

Use only the recommended fuse type. If a fuse with a higher current rating is installed, instrument damage may occur.

Table 5-1. Fuse Replacements

Function	Fuse Type	Keithley Part No.
AMPS Fuse	2A, 250V, Normal-Blo, 5mm x 20mm	FU-48
Line Fuse	1/8A, 250V, Slo-Blo 5mm x 20mm	FU-91

4. To replace the fuse carrier with the fuse, reverse the procedure in step 2.

5.3.2 Line Fuse

The line fuse is located internally in the Model 175-AV. The top cover must be removed to gain access to the fuse. For exact fuse location, refer to Figure 6-1.

Top Cover Removal

1. Turn off the power and disconnect the line cord and all test leads from the instrument.
2. Turn the unit over and remove the four screws from the bottom of the case.
3. Turn the unit over again and separate the top cover from the rest of the unit.

Fuse Replacement

1. If the Model 1753-AV IEEE-488 interface is installed, it must be removed to access to the fuse. The IEEE-488 board is secured to the mother board by a support post at the rear and a connector on the left side. To remove, lift the board up until it disengages from the support post and connector.
2. Remove the fuse and replace it with the proper type using Table 5-1 as a guide.

CAUTION

Do not use a fuse with a rating higher than specified or instrument damage may occur. If the instrument repeatedly blows fuses, locate and correct the cause of the trouble before replacing the fuse.

3. If the IEEE-488 interface was installed, reinstall by reversing the procedure in step 1.
4. To reinstall the top cover, position the tilt bail properly into the bottom cover and reverse the top cover removal procedure.

5.4 CALIBRATION

Calibration should be performed every 12 months, or if the performance verification procedures in Section 3 show that the Model 175-AV is out of specification. If any of the calibration procedures cannot be performed properly, refer to the troubleshooting information in this section. If the problem persists, contact your Keithley representative or the factory for further information.

The entire calibration procedure may be performed without having to make any internal adjustments if frequency compensation has been verified, as explained in paragraph 5.4.8. It is suggested that the 2V, 20V, and 200V ranges at 10kHz be checked (Section 3, Performance Verification) before proceeding.

Calibration can be performed from the front panel or over the IEEE-488 bus. The Model 1755 Calibration Interface can be used for IEEE-488 bus calibration of Model 175-AV units without installed interfaces.

WARNING

Some procedures require the use of high voltage. Take care to prevent contact with live circuits, which could cause electrical shock resulting in injury or death.

NOTE

Calibration can be stopped at any time and only selected ranges can be calibrated if needed.

5.4.1 Recommended Calibration Equipment

Table 5-2 lists recommended calibration equipment. Alternate equipment may be used as long as equipment accuracy is at least as good as the specifications listed in the table.

5.4.2 Environmental Conditions

Calibration should be performed under laboratory conditions having an ambient temperature of 23 ±3°C and a relative humidity of less than 70%.

5.4.3 Warm-Up Period

Turn on the instrument power and allow it warm up for at least one hour before beginning the calibration procedure. If the instrument has been subjected to extremes of temperature or humidity, allow at least one additional hour for the instrument to stabilize before beginning the calibration procedure.

5.4.4 CALIBRATION Switch

The Model 175-AV is shipped from the factory with its external CALIBRATION switch in the DISABLED position. In this position, calibration constants are not stored in non-volatile memory, when entered from the front panel or over the IEEE-488 bus. The switch must be moved to the ENABLED position to allow calibration constant storage.

The CALIBRATION switch is shown in Figure 5-1 (it is normally covered by the CALIBRATED label). Remove the label and slide the switch to ENABLED. Turn the instrument off, then on, and press in the REL and dB pushbuttons simultaneously until the message "CAL" is displayed. Release the buttons. The unit is now in the calibration mode as indicated by the "C" annunciator.

5.4.5 Dc Voltage Calibration From Front Panel

Connect the calibration source to the INPUT HI and LO terminals of the Model 175-AV.

1. Ensure that the Model 175-AV is in the calibration mode ("C" annunciator on), as explained in paragraph 5.4.4.
2. Select the 200mV dc range on the Model 175-AV.
3. Set the voltage calibrator to output 0V.
4. Press the REL button (REL on).
5. Set the voltage calibrator output (+190.000mV for the 200mV range, see Table 5-3 for other ranges).
6. Adjust the Model 175-AV displayed reading (190.00mV for the 200mV range, also see Table 5-3)

Table 5-2. Recommended Calibration Equipment

Description	Specifications	Manufacturer and Model
dc Voltage Calibrator	200mV, 2V, 20V, 200V, 1100V ranges, ±0.005% accuracy.	Fluke 5101B
ac Voltage Calibrator	200mV, 2V, 20V, 200V, 1100V ranges, ±0.05% accuracy.	Fluke 5101B
Resistance Calibrator	100Ω, 1kΩ, 10kΩ, 100kΩ ranges, ±0.005%; 1MΩ range, ±0.01%; 10MΩ range, ±0.05%	Fluke 5101B

with the use of the STO/CLR and RCL buttons. The STO/CLR button increments the displayed reading; the RCL button decrements the displayed reading.

7. Select the next dc voltage range on the Model 175-AV.
8. Repeat steps 3 through 7 for the remaining ranges, calibrator voltages, and readings as listed in Table 5-3.

Table 5-3. dc Voltage Calibration

175-AV Range	Calibrator Voltage	175-AV Reading
200 mV	190.000 mV	190.00 mV
2 V	1.90000 V	1.9000 V
20 V	19.0000 V	19.000 V
200 V	190.000 V	190.00 V
1000 V	1000.00 V	1000.0 V

5.4.6 Ac Voltage Calibration From Front Panel

With the Model 175-AV still in the calibration mode ("C" annunciator on), select the ac volts function and connect the calibrator to the INPUT HI and LO terminals of the Model 175-AV. Steps 1 through 6 must be performed in the exact sequence listed.

1. Select the 200mV range and set the calibrator to output 190.000mV @ 200Hz.
2. Adjust the Model 175-AV display using the STO/CLR and RCL buttons to read 190.00mV ac.
3. Press the dB button and verify that the dB annunciator is on.
4. Set the calibrator to output 19.0000mV @ 200Hz.
5. Adjust the display to read 19.00mV.
6. Press the REL button and verify that the dB annunciator is off.
7. Repeat only steps 1 and 2 for the remaining ranges using Table 5-4 as a guide.

5.4.7 Resistance Calibration From Front Panel

With the Model 175-AV still in the calibration mode ("C" annunciator on), select the Ω function and connect the test leads to the INPUT HI and LO terminals of the Model 175-AV. Table 5-5 summarizes the procedure.

1. With the test leads connected to the Model 175-AV, short the other ends together.
2. Select the 200Ω range and press the REL button on the Model 175-AV. The REL annunciator will turn on and the display will zero (test lead compensation).
3. Disconnect the short and connect the test leads to the calibrator.
4. Set the calibrator to output 100Ω and adjust the Model 175-AV display, using the STO/CLR and RCL buttons for a reading of 100.00Ω.
5. Press the REL button and note that the REL annunciator turns off.
6. Select the 2kΩ range and again short the test leads together.
7. Press the REL button. The REL annunciator will turn on and the display will zero.
8. Reconnect the test leads, set the calibrator to output 1kΩ, and adjust the Model 175-AV for a reading of 1.0000kΩ.
9. Press the REL button to turn off REL.
10. Select the 20kΩ range and set the calibrator to output 10kΩ. Adjust the Model 175-AV to read 10.000kΩ.

175-AV Range	Calibrator Voltage	Calibrator Frequency	175-AV Reading
200 mV	190.000 mV	200Hz	190.00 mV
200 mV*	19.0000 mV	200Hz	19.00 mV
2 V	1.90000 V	200Hz	1.9000 V
20 V	19.0000 V	200Hz	19.000 V
200 V	190.000 V	200Hz	190.00 V
750 V	750.00 V	200Hz	750.0 V

*dB annunciator must be on (indicated two-point calibration).

11. Repeat step 8 for the 200kΩ, 2MΩ and 20MΩ ranges using Table 5-5 as a guide.

Table 5-5. Resistance Calibration

175-AV Range	REL*	Calibration Resistance	175-AV Reading
200 Ω	on	100 Ω	100.00 Ω
2 kΩ	on	1 kΩ	1.0000 kΩ
20 kΩ	off	10 kΩ	10.000 kΩ
200 kΩ	off	100 kΩ	100.00 kΩ
2 MΩ	off	1 MΩ	1.0000 MΩ
20 MΩ	off	10 MΩ	10.000 MΩ

*REL is used to compensate for test lead resistance on the 200Ω and 2kΩ ranges.

5.4.8 Frequency Compensation

Check high frequency (10kHz) ac volts accuracy as explained in Section 3, Performance Verification. In the event that frequency compensation must be performed, three internal trimmer capacitors will have to be adjusted. When making adjustments use a flat-bladed, insulated calibration tool.

The trimmer capacitors are accessible through the shield (see Figure 6-1). Once the top cover is removed, as described in paragraph 5.3.2, the shield and PC board must be secured to the bottom cover to prevent movement. This assembly can be secured with two screws and nuts in place of the top cover. Proceed as follows:

1. Set the Model 175-AV for 200Vac and set the calibrator to output 100.000V @ 10kHz.
2. Adjust C101 for a reading of 100.00 ±3 counts.
3. Select the 2V range and set the calibrator to output 1.00000V @ 10kHz.
4. Adjust C104 for a reading of 1.0000 ±8 counts.
5. Repeat steps 1 and 2.
6. Select the 20V range and set the calibrator to output 10.0000V @ 10kHz.
7. Adjust C107 for a reading of 10.000 ±8 counts.

5.4.9 Calibration Storage

To store the calibration constants, simultaneously press the REL and dB buttons until the message "Stor" is displayed. If instead the message "out" is displayed, then calibration storage was not enabled and the calibration constants will only be valid until the Model 175-AV is turned off.

To save the calibration constants after "out" appears on the display, slide the CALIBRATION switch to ENABLED. Press REL and dB simultaneously until "CAL" appears on the display. Then simultaneously press REL and dB until "Stor" is displayed. The calibration constants are now stored in non-volatile memory.

Slide the CALIBRATION switch back to the DISABLED position. Replace the CALIBRATED label (Keithley part number MC-561) on the rear panel, completely covering the CALIBRATION switch.

5.4.10 IEEE-488 Bus Calibration

The Model 175-AV, with the Model 1753-AV installed, can be calibrated over the lEEE-488 bus with the use of a programmable calibrator and a controller.

The following program can be used to calibrate the Model 175-AV over the IEEE-488 bus. Use the equipment listed below:

- Keithley Model 1753-AV IEEE-488 Interface
- Fluke Model 5100 Series B Calibrator with Model 5100A-05 IEEE-488 Interface.
- Hewlett-Packard Model HP-85 Computer with the following:

1. Model HP 82937A HP-IB Interface
2. Model HP 82936A ROM Drawer
3. I/O ROM (0085-15003)

Detailed operating instructions for the Model 1753-AV bus interface can be found in the Model 1753 Instruction Manual.

Programming Example

Use the following procedure, along with the equipment listed previously, to calibrate a Model 175-AV over the IEEE-488 bus.

1. Place the rear panel CALIBRATION switch in the ENABLED position and enter calibration mode as described in paragraph 5.4.4.
2. Configure the Model 175-AV/1753-AV, HP-85, and the Model 5100 Calibrator as a system by connecting the instruments together with IEEE-488 cables.
3. Set the primary address of the Model 175-AV/1753-AV to 24 (11000). Set the Model 5100 Calibrator to 17 (10001).
4. Turn the instruments on and allow a one hour warm-up.
5. Type the program listed at the end of this section into the HP-85.
6. After step 5 is complete, check the program to make sure there are no mistakes. If the program has even a small mistake it will not operate as intended.
7. Connect the output of the Model 5100 Calibrator to INPUT HI and LO terminals of the Model 175-AV.
8. Press the RUN key on the HP-85 to initiate the program.
9. The program will stop at certain pre-determined points to prompt the user to change functions. When the prompt instructions have been completed, press CONT on the HP-85 to resume the program.
10. When the "calibration is now complete" message is displayed, slide the CALIBRATION switch back to the DISABLED position.
11. Replace the CALIBRATED label (Keithley part number MC-561) on the rear panel, completely covering the CALIBRATION switch.

5.5 SPECIAL HANDLING OF STATIC SENSITIVE DEVICES

CMOS devices operate at very high impedance levels for low power consumption. As a result, any static charge that builds up on your person or clothing may be sufficient to destroy these devices, if they are not handled properly.

CAUTION

Since the many CMOS devices installed in the Model 175-AV are not denoted in this manual, all ICs and transistors should be handled as static-sensitive devices.

When handling these devices, use the following precautions to avoid damaging them:

1. Transport such devices only in containers designed to prevent static build-up. Typically, these parts will be received in anti-static containers of plastic or foam. Always leave the devices in question in their original containers until ready for installation.
2. Remove the devices from their protective containers only at a properly grounded work station. Also ground yourself with a suitable wrist strap.
3. Handle the devices only by the body; do not touch the pins or terminals.
4. Any printed circuit board into which the device is to be inserted must also be properly grounded to the bench or table.
5. Use only anti-static type de-soldering tools.
6. Use only soldering irons with properly grounded tips.
7. Once the device is installed on the PC board, it is usually adequately protected, and normal handling can resume.

5.6 TROUBLESHOOTING

The troubleshooting information contained in this section is intended for use by qualified personnel having a basic understanding of analog and digital circuitry. The individual should also be experienced at using typical test equipment as well as ordinary troubleshooting procedures.

The information presented here has been written to assist in isolating a defective circuit or circuit section. Isolation of the specific component is left to the technician. Note that schematic diagrams and component location drawings, which are an essential aid in troubleshooting, are located at the end of Section 6.

NOTE

Avoid touching the PC board or its component parts. Handle the PC board by its edges.

5.6.1 Recommended Test Equipment

Success in troubleshooting instruments like the Model 175-AV depends not only on the skill of the technician, but relies on the use of accurate, reliable test equipment. Table 5-6 lists the equipment recommended for troubleshooting the Model 175-AV. Other equipment,

such as logic analyzers and capacitance meters, could also be helpful, especially in difficult situations.

Table 5-6. Recommended Troubleshooting Equipment

Equipment	Use
Five-function DMM with 0.05% basic dc accuracy, 10MΩ input impedance	Power supply and dc voltage checks, analog signal tracing, continuity, static logic levels.
Dual-trace, triggered-sweep oscilloscope, dc to 50MHz bandwidth.	Digital and analog waveform checks.

5.6.2 Self Diagnostic Program

To use the self diagnostic program, hold in the dB button and turn on the Model 175-AV. The following will occur:

1. All LCD digits and annunciators will turn on.
2. The software revision level will be displayed (e.g., A1).
3. The sequential display test will run.
4. The Model 175-AV will go into the troubleshooting test mode.

If the dB button is released, the instrument will flag either RAM or NVRAM self test failures, should they occur. If neither RAM nor NVRAM fails, the instrument will default to the troubleshooting test mode.

RAM Test

If the RAM test fails, the Model 175-AV will lock up with all zeros displayed. Replacing U113 may correct problem.

Non-volatile RAM Test

If the NVRAM test fails, the following message will be displayed:

This message indicates that the instrument is probably not properly calibrated, since calibration constants are stored in the non-volatile RAM. The Model 175-AV will lock up at this point if the test fails, but operation may be restored for troubleshooting by pressing any front panel control button. The flashing "C" annunciator will indicate that the unit failed the NVRAM test.

At this point, try calibrating the instrument with the constants already entered by simultaneously pressing in REL and dB until "CAL" is displayed, and then again until "Stor" is displayed. If the error gets corrected, indicating that the NVRAM is probably good, a full calibration will be needed. If the error persists, try replacing the NVRAM chip (U110). Again, the Model 175-AV must undergo a complete calibration after the problem is corrected.

Sequential Display Test

Segments and annunciators are sequentially displayed in eight steps. Use Figure 5-2 for segment identification. The steps are as listed in Table 5-7.

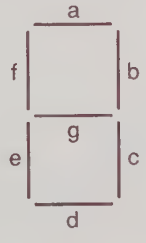


Figure 5-2. Segment Identification

Table 5-7. Sequential Display Test Steps

Step	Segment of Digits	Annunciators
1	a	dB, V
2	b	none
3	c	none
4	d	m (mA), RCL, RMT
5	e	minus sign, REL, M, Ω
6	f	AUTO, BAT, m (mV), C
7	g	AC, k
8	none	decimal points, most significant digit, STO, μ, A

Troubleshooting Test Modes

The troubleshooting mode is designed to switch on various switching FETs, transistors, and logic levels to allow signal tracing through the instrument. The first displayed mode will reflect the selected function and range. For example, assume that "0u1" is displayed. The "0" is the test number, the "u" corresponds to the volts function, and the "1" corresponds to the 200mV range. The test number can be changed by pressing in the dB button. Table 5-8 lists the test modes for all functions and ranges.

To update the test mode, select the new function and range and hold in the dB button until the function symbol changes.

Troubleshooting consists of selecting the desired test mode and using the data found in Table 5-8 to signal trace the circuit.

Notes:

1. When a different function or range is selected, the dB button must be pressed and held in to update the display with the corresponding test mode.
2. Do not use AUTO when in ac or dc volts.
3. Use AUTO when checking circuitry on the 20MΩ and 200MΩ ranges (Xo6).

Table 5-8. Troubleshooting Modes

Function & Range	Test Mode	AMP Gain (U105*)	Multiplexer FET On	Ohms Range Transistor On	Range Control Logic level on U114			
					PA0	PA1	PA2	PA3
200mVdc	0u1	x10	Q110		1	1	1	1
	1u1	x10	Q111		1	1	1	1
	2u1	x1	Q113		1	1	1	1
	3u1	x1	Q111		1	1	1	1
2Vdc	0u2	x1	Q110		1	1	1	1
	1u2	x1	Q111		1	1	1	1
	2u2	x1	Q113		1	1	1	1
	3u2	x1	Q111		1	1	1	1
20Vdc	0u3	x1	Q110		1	0	1	1
	1u3	x1	Q111		1	0	1	1
	2u3	x1	Q113		1	0	1	1
	3u3	x1	Q111		1	0	1	1
200Vdc	0u4	x1	Q110		1	0	0	1
	1u4	x1	Q111		1	0	0	1
	2u4	x1	Q113		1	0	0	1
	3u4	x1	Q111		1	0	0	1
1000Vdc	0u5	x1	Q110		0	0	1	1
	1u5	x1	Q111		0	0	1	1
	2u5	x1	Q113		0	0	1	1
	3u5	x1	Q111		0	0	1	1
200mVac	0u1	x10	Q110		1	1	1	1
	1u1	x10	Q111		1	1	1	1
	2u1	x1	Q113		1	1	1	1
	3u1	x1	Q111		1	1	1	1
2Vac	0u2	x10	Q110		1	0	1	1
	1u2	x10	Q111		1	0	1	1
	2u2	x1	Q113		1	0	1	1
	3u2	x1	Q111		1	0	1	1
20Vac	0u3	x10	Q110		1	0	0	1
	1u3	x10	Q111		1	0	0	1
	2u3	x1	Q113		1	0	0	1
	3u3	x1	Q111		1	0	0	1
200Vac	0u4	x10	Q110		1	0	1	1
	1u4	x10	Q111		1	0	1	1
	2u4	x1	Q113		1	0	1	1
	3u4	x1	Q111		1	0	1	1
750Vac	0u5	x10	Q110		0	0	1	1
	1u5	x10	Q111		0	0	1	1
	2u5	x1	Q113		0	0	1	1
	3u5	x1	Q111		0	0	1	1
acA & dcA ALL Ranges	0A1-0A6	x10	Q110		0	0	0	1
	1A1-1A6	x10	Q111		0	0	0	1
	2A1-2A6	x1	Q113		0	0	0	1
	3A1-3A6	x1	Q111		0	0	0	1

Troubleshooting Modes (Cont.)

Function & Range	Test Mode	AMP Gain (U105*)	Multiplexer FET On	Ohms Range Transistor On	Range Control Logic level on U114			
					PA0	PA1	PA2	PA3
200 Ω	0o1	x10	Q110	Q104	1	1	1	0
	1o1	x10	Q111	Q104	1	1	1	0
	2o1	x1	Q112	Q104	1	1	1	0
	3o1	x1	Q110	Q104	1	1	1	0
	4o1							
	5o1	x1	Q111	Q104	1	1	1	0
	6o1	x1	Q113	Q104	1	1	1	0
2k Ω	0o2	x1	Q110	Q104	1	1	1	0
	1o2	x1	Q111	Q104	1	1	1	0
	2o2	x1	Q112	Q104	1	1	1	0
	3o2	x1	Q110	Q104	1	1	1	0
	4o2							
	5o2	x1	Q111	Q104	1	1	1	0
	6o2	x1	Q113	Q104	1	1	1	0
20k Ω	0o3	x10	Q110	Q105	0	1	1	1
	1o3	x10	Q111	Q105	0	1	1	1
	2o3	x1	Q112	Q105	0	1	1	1
	3o3	x1	Q110	Q105	0	1	1	1
	4o3							
	5o3	x1	Q111	Q105	0	1	1	1
	6o3	x1	Q113	Q105	0	1	1	1
200kΩ	0o4	x1	Q110	Q105	0	1	1	1
	1o4	x1	Q111	Q105	0	1	1	1
	2o4	x1	Q112	Q105	0	1	1	1
	3o4	x1	Q110	Q105	0	1	1	1
	4o4							
	5o4	x1	Q111	Q105	0	1	1	1
	6o4	x1	Q113	Q105	0	1	1	1
2M Ω (M Ω)	0o5	x10	Q110	Q102	1	1	0	1
	1o5	x10	Q111	Q102	1	1	0	1
	2o5	x1	Q113	Q102	1	1	0	1
	3o5	x1	Q110	Q102	1	1	0	1
	4o5							
	5o5	x1	Q111	Q102	1	1	0	1
	6o5	x1	Q113	Q102	1	1	0	1
20 & 200M Ω (M Ω)	0o6	x1	Q110	Q102	1	1	0	1
	1o6	x1	Q111	Q102	1	1	0	1
	2o6	x1	Q113	Q102	1	1	0	1
	3o6							
	4o6							
	5o6	x1	Q111	Q102	1	1	0	1
	6o6	x1	Q113	Q102	1	1	0	1

*+4 to 5V (Logic 1) at pin 9 of U106B selects x10 gain, 0V (Logic 0) at pin 9 of U106B selects x1 gain.

5.6.3 Power Supply and Battery Pack (Model 1758) Checks

Table 5-9 shows the various checks that can be made to the power supplies within the Models 175-AV and 1758. In addition to the normal voltage checks, it is a good idea to check the various supplies with an oscilloscope to make sure no noise or ringing are present.

5.6.4 A/D Converter and Display

Make sure the A/D converter and display are operating properly before attempting to troubleshoot the signal conditioning circuits. Check these circuits using the information in Tables 5-10 and 5-11.

5.6.5 Signal Conditioning

These circuits can be checked by using the diagnostic program (troubleshooting modes). See paragraph 5.6.2.

Table 5-9. Power Supply Checks and Battery Pack (Model 1758) Checks

Step	Item/Component	Required Condition	Remarks
1	S102 Line Switch	Set to 115 or 230V as required.	S102 externally accessible from rear panel.
2	F102 Line Fuse	Continuity.	
3	Line Cord	Plugged into line receptacle; power on.	
4	U116** Input (Vin)	+12V ±10%	+5V regulator input.
5	U116** Output (Vo)	+5V ±5%	+5V regulator output.
6	U117 Input (Vin)	–20V to –14V	Negative supply input.
7	U117 Output (Vo)	–10V ±10%	Negative supply output.
8	VR101	–6.25V to –6.45V	Reference zener diode.
9	U103 pin 6	–7V ±5%	Low noise negative supply.
10*	Q101 base	0.6V while charging (power switch off)	Current sink.
11*		Line cord disconnected, battery pack charged, power switch on.	
12*	U101 pin 8	>8.8V	Voltage inverter.
13*	U102 pin 7	+5V with batteries charged.	Voltage comparator.

*Checks for the Model 1758
**If U116 is replaced, be sure that the device is properly seated on the mother board so that it will not touch the IEEE board (if installed).

Table 5-10. A/D Converter Checks

Step	Item/Component	Required Condition	Remarks
1		Turn on power; select 2V dc range. Short input.	
2	U123, pin 38	3.2768MHz clock	Crystal (Y101)
3	U122, pin 10	655.36kHz clock	Address strobe
4	U122, pin 6	81.92kHz clock	Synchronous clock for A/D
5	U122, pin 5	40.96kHz clock	Synchronous clock for A/D
6	U122, pin 7	163.84kHz clock	Synchronous clock for A/D
7	U122, pin 12	1.28kHz clock	Integrator timebase and real time interrupt.
8	U119B, pin 6	+5V to ≈0V pulse train, 3µsec duration every 22µsec	Charge balance synchronization signal.
9	U104, pin 6	Integrator Ramp	
10	U108, pin 6	≈1.5V	Comparator reference
11	U108B, pin 7	Variable pulse train 0V to +5V	Comparator output
12	U121A, pin 6	Variable pulse train, 0V to +5V.	Reference current generator
13	U107A, pin 15	Variable pulse train, 0V to +5V.	
14	U107A, pin 10	≈5msec positive going pulses.	Control line for charge balance/single slope.
15	U121B, pin 9	100msec positive going pulse.	Control line for integrator

Table 5-11. Display Board Checks

Step	Item/Component	Required Condition	Remarks
1		Turn on power; select the 2Vdc range.	
2	P1006, pin 5	+3.33V	Vlcd1
3	P1006, pin 6	+1.66V	Vlcd2
4	P1006, pin 7	+5V ±5%	Power to display
5	P1006, pin 2	81.92kHz	clock.
6	P1006, pin 1	0V to +5V pulses	Data from microprocessor
7	P1006, pin 12	0V to +5V pulses	Data from microprocessor
8	P1006, pin 13	0V to +5V pulses	Data from microprocessor
9	P1006, pin 14	+5V to 0V pulses	Data from microprocessor
10	LCD	Check that LCD is positioned properly.	
11	Connector (P1006)	Check that connector is not reversed. If reversed, display test will run, then display will blank.	
12	Strip Connectors	Check that they are positioned properly.	

5.7 MODEL 1758 BATTERY PACK INSTALLATION AND REMOVAL

Refer to Figure 6-1 and perform the appropriate following procedure to install or remove the battery pack.

WARNING

Installation and removal of the battery pack should only be performed by qualified personnel. Disconnect the line cord and remove all test leads from the Model 175-AV.

CAUTION

Do not allow the battery leads to short together or damage to the batteries may occur.

NOTE

It is not recommended that the battery packs be stored at temperatures above 50°C.

Battery Pack Installation

1. Remove the top cover as explained in paragraph 5.3.2.
2. Remove the screw that connects the shield to the PC board. Ease the shield out of the unit.
3. Position the battery board as shown in Figure 6-1 and secure it to the shield using two supplied screws. The screws are fed through the shield into the battery board fasteners.
4. Place the battery pack in the bracket and position it on the shield as shown. Feed the two screws through the shield into the bracket and tighten.
5. Carefully place the shield (with battery pack) back into the Model 175-AV so that it seats properly on the two spacers. Replace the screw that connects the shield to the PC board.
6. Connect the ribbon cable from the battery board to the male connector (marked BATT.) on the mother board.

CAUTION

Make a close visual inspection to ensure that the connectors are properly mated or damage to the instrument may result.

7. Connect the red battery lead to the +RED terminal pin on the battery board. Connect the black battery lead to the –BLK terminal pin on the battery board.
8. Reinstall the top cover as explained in paragraph 5.3.2.
9. Charge the battery pack per the instructions in paragraph 2.3.3.

Battery Pack Removal

1. Remove the top cover as explained in paragraph 5.3.2.
2. Disconnect the battery board ribbon cable from the mother board connector.
3. Disconnect the battery leads from the terminal pins on the battery board.
4. Remove the screw that connects the shield to the PC board. Ease the assembly out of the unit.
5. Remove the two screws holding the bracket to the shield.
6. Remove the battery pack from its bracket.
7. Remove the two screws holding the battery board to the shield.
8. Place the shield back into the Model 175-AV so that it seats properly on the two spacers. Replace the screw that connects the shield to the PC board.
9. Reinstall the top cover as explained in paragraph 5.3.2.

PROGRAM	COMMENTS
10 REMOTE 724, 717	
20 CLEAR	
30 DISP " "	
40 DISP "THIS PROGRAM RUNS A FULL CALI BRATION ON THE MODEL 175-AV USING THE FLUKE MODEL 5101B"	
50 DISP " "	
60 DISP "PRESS CONT TO RESUME PROGRAM"	
70 PAUSE	
80 CLEAR	
90 DISP " "	
100 DISP "SELECT THE DCV FUNCTION AND CON NECT THE CALIBRATION SOURCE"	DC VOLTS CALIBRATION
110 DISP " "	
120 DISP " "	
130 DISP "PRESS CONT TO RESUME PROGRAM"	
140 DISP " "	
150 PAUSE	
160 OUTPUT 724; "R1X"	Sets 175-AV to 200mV range.
170 OUTPUT 717; "0V,N"	Outputs 0V to 175-AV.
180 WAIT 1000	
185 OUTPUT 724; "V.1X"	Put 175-AV in CAL mode.
190 OUTPUT 724; "Z1X"	Turns REL on.
200 WAIT 1000	
210 OUTPUT 717; ".19V,N"	Outputs 190mV to 175-AV.
220 WAIT 5000	
230 OUTPUT 724; "V.19X"	Calibrates 200mV range.
240 WAIT 2000	
250 OUTPUT 724; "R2X"	Sets 175-AV to 2V range.
260 OUTPUT 717; "0V,N"	Outputs 0V to 175-AV.
270 WAIT 1000	
280 OUTPUT 724; "Z1X"	Turns REL on.
290 WAIT 1000	
300 OUTPUT 717; "1.9V, N"	Outputs 1.9V to 175-AV.
310 WAIT 5000	
320 OUTPUT 724; "V1.9X"	Calibrates 2V range.
330 WAIT 2000	
340 OUTPUT 724; "R3X"	Sets 175-AV to 20V range.
342 OUTPUT 717; "0V,N"	Outputs 0V to 175-AV.
344 WAIT 1000	
346 OUTPUT 724; "Z1X"	Turns REL on.
348 WAIT 1000	
350 OUTPUT 717; "19V,N"	Outputs 19V to 175-AV.
360 WAIT 5000	
370 OUTPUT 724; "V19X"	Calibrates 20V range.
380 WAIT 2000	
390 OUTPUT 717; "S"	Sets 5101B to standby.
400 OUTPUT 724; "R4X"	Sets 175-AV to 200V range.
410 CLEAR	
420 BEEP 50, 1000	
430 DISP " "	

PROGRAM	COMMENTS
440 DISP "WARNING! THE FOLLOWING STEPS USE HIGH VOLTAGE!"	
450 DISP " "	
460 DISP "PRESS CONT TO RESUME PROGRAM"	
470 DISP " "	
480 PAUSE	
490 DISP " "	
492 OUTPUT 717; "0V,N"	Outputs 0V to 175-AV.
494 WAIT 1000	
496 OUTPUT 724; "Z1X"	Turns REL on.
498 WAIT 1000	
500 OUTPUT 717; "190V,N"	Outputs 190V to 175-AV.
510 WAIT 5000	
520 OUTPUT 724; "V190X"	Calibrates 200V range.
530 WAIT 2000	
540 OUTPUT 724; "R5X"	Sets 175-AV to 1000V range.
542 OUTPUT 717; "0V,N"	Outputs 0V to 175-AV.
544 WAIT 1000	
546 OUTPUT 724; "Z1X"	Turns REL on.
548 WAIT 1000	
550 OUTPUT 717; "1000V,N"	Outputs 1000V to 175-AV.
560 WAIT 5000	
570 OUTPUT 724; "V1000X"	Calibrates 1000V range.
580 WAIT 2000	
590 OUTPUT 717; "S"	Sets 5101B to standby.
600 CLEAR	
610 BEEP 50, 1000	
620 DISP " "	
630 DISP "DC VOLTS CALIBRATION IS NOW COMPLETE"	
640 DISP " "	
650 DISP "SELECT AC VOLTS and ..."	AC VOLTS CALIBRATION
660 WAIT 2000	
670 DISP " "	
680 DISP "PRESS CONT TO RESUME PROGRAM"	
690 PAUSE	
700 OUTPUT 724; "R1X"	Sets 175-AV to 200mV range.
710 OUTPUT 717; ".19V200H,N"	Outputs 190mV at 200Hz to 175-AV.
720 WAIT 5000	
730 OUTPUT 724; "V.19X"	Calibrates high end of 200mV range.
740 WAIT 2000	
750 OUTPUT 724; "D1X"	Turns dB annunciator on.
760 OUTPUT 717; "19E–3V200H,N"	Outputs 19mV at 200Hz to 175-AV.
770 WAIT 5000	
780 OUTPUT 724; "V19E–3X"	Calibrates low end of 200mV range.
790 WAIT 2000	
800 OUTPUT 724; "Z0X"	Turns dB annunciator off.
810 WAIT 5000	
820 OUTPUT 724; "R2X"	Sets 175-AV to 2V range.
830 OUTPUT 717; "1.9V200H,N"	Outputs 1.9V at 200Hz to 175-AV.
840 WAIT 5000	
850 OUTPUT 724; "V1.9X"	Calibrates 2V range.
860 WAIT 2000	

PROGRAM	COMMENTS
870 OUTPUT 724; "R3X"	Sets 175-AV to 20V range.
880 OUTPUT 717; "19V200H,N"	Outputs 19V at 200Hz to 175-AV.
890 WAIT 5000	
900 OUTPUT 724; "V19X"	Calibrates 20V range.
910 WAIT 2000	
920 OUTPUT 717; "S"	Sets 5101B to standby.
930 OUTPUT 724; "R4X"	Sets 175-AV to 200V range.
940 CLEAR	
950 BEEP 50, 1000	
960 DISP " "	
970 DISP "WARNING! THE NEXT STEPS USE HIGH VOLTAGE!"	
980 DISP " "	
990 DISP "PRESS CONT TO RESUME PROGRAM"	
1000 PAUSE	
1010 OUTPUT 717; "190V200H,N"	Outputs 190V at 200Hz to 175-AV.
1020 WAIT 5000	
1030 OUTPUT 724; "V190X"	Calibrates 200V range.
1040 WAIT 2000	
1050 OUTPUT 717; "S"	Sets 5101B to standby.
1060 OUTPUT 724; "R5X"	Sets 175-AV to 750V range.
1070 OUTPUT 717; "750V400H,N"	Outputs 750V at 400Hz to 175-AV.
1080 WAIT 5000	
1090 OUTPUT 724; "V750X"	Calibrates 750V range.
1100 WAIT 2000	
1110 OUTPUT 717; "S"	Sets 5101B to standby.
1120 CLEAR	
1130 BEEP 50, 1000	
1140 DISP " "	
1150 DISP "AC VOLTS CALIBRATION IS COMPLETE"	
1160 WAIT 2000	
1170 DISP " "	
1180 DISP "SELECT OHMS and REMEMBER TO RELEASE THE AC BUTTON"	OHMS CALIBRATION
1190 WAIT 2000	
1200 DISP " "	
1210 DISP "PRESS CONT TO RESUME PROGRAM"	
1220 PAUSE	
1230 CLEAR	
1240 OUTPUT 724; "R1X"	Sets 175-AV to 200Ω range.
1250 FOR H=0 TO 1	Sets program for one loop.
1260 GOTO 1270	
1270 OUTPUT 717; "1Z,N"	Outputs 1Ω to 175-AV.
1280 WAIT 5000	
1290 ENTER 724; D	Enter displayed reading (D).
1300 A=D–1	A = Test lead resistance and cal error.
1310 OUTPUT 717; "100Z,N"	Output 100Ω to 175-AV.
1320 WAIT 5000	
1330 B=100	B = 100Ω from 5101B.
1340 F=B+A	F = Cal point plus lead resistance and cal error.
1350 C$="V"&VAL$(F)&"X"	C$ = Command that calibrates 175-AV using F.
1360 OUTPUT 724; C$	Calibrate 200Ω range.

PROGRAM	COMMENTS
1370 WAIT 2000	
1380 NEXT H	Loops to line 1250 once.
1390 OUTPUT 724; "R2X"	Sets 175-AV to 2kΩ range.
1400 FOR H=0 TO 1	Sets program for one loop.
1410 GOTO 1420	
1420 OUTPUT 717; "1Z,N"	Outputs 1Ω to 175-AV.
1430 WAIT 5000	
1440 ENTER 724; D	Enter displayed reading (B).
1450 A=D–1	A = Test lead resistance and cal error.
1460 OUTPUT 717; "1E3Z,N"	Output 1kΩ to 175-AV.
1470 WAIT 5000	
1480 B=1000	B = 1000Ω from 5101B.
1490 F=B+A	F = Cal points plus lead resistance and cal error.
1500 C$="V"&VAL$(F)&"X"	C$ = Command that calibrates 175-AV using F.
1510 OUTPUT 724; C$	Calibrates 2kΩ range.
1520 WAIT 2000	
1530 NEXT H	Loops to line 1400 once.
1540 OUTPUT 724; "R3X"	Sets 175-AV to 20kΩ range.
1550 OUTPUT 717; "10E3Z,N"	Outputs 10kΩ to 175-AV.
1560 WAIT 5000	
1570 OUTPUT 724; "V10E3X"	Calibrates 20kΩ range.
1580 WAIT 2000	
1590 OUTPUT 724; "R4X"	Sets 175-AV to 200kΩ range.
1600 OUTPUT 717; "100E3Z, N"	Outputs 100kΩ to 175-AV.
1610 WAIT 5000	
1620 OUTPUT 724; "V100E3X"	Calibrates 200kΩ range.
1630 WAIT 2000	
1640 OUTPUT 724; "R5X"	Sets 175-AV to MΩ ranges.
1650 OUTPUT 717; "1E6Z,N"	Outputs 1MΩ to 175-AV.
1660 WAIT 5000	
1670 OUTPUT 724; "V1E6X"	Calibrates 2MΩ range.
1680 WAIT 2000	
1690 OUTPUT 717; "10E6Z,N"	Outputs 10MΩ to 175-AV.
1700 WAIT 5000	
1710 OUTPUT 724; "V10E6X"	Calibrates 20MΩ range.
1720 WAIT 2000	
1730 BEEP 50, 1000	
1740 DISP "CAL POINTS ARE NOW ENTERED"	
1750 WAIT 1000	
1760 DISP " "	
1770 DISP "DO YOU WISH TO STORE CAL POINTS IN NVRAM?"	
1780 WAIT 1000	
1790 DISP " "	
1800 DISP "IF YES, PRESS Y and END LINE"	
1810 DISP "IF NO, PRESS N and END LINE"	
1820 INPUT A$	
1830 IF A$="Y" THEN 1850	
1840 IF A$="N" THEN 1910	
1850 OUTPUT 724; "L0X"	Stores calibration points in NVRAM.
1860 WAIT 2000	

PROGRAM	COMMENTS

```
1870  FOR I=1 TO 25
1880  BEEP I*RND+1, 50
1890  NEXT I
1900  BEEP 40, 3000
1910  "DISP "**********"
1920  DISP "THE MODEL 175-AV CALIBRATION IS NOW
      COMPLETE."
1930  "DISP "**********"
1940  END
```

SECTION 6
Replaceable Parts

6.1 INTRODUCTION

This section contains replacement parts information, component location drawings, and schematic diagrams for the Model 175-AV.

6.2 PARTS LIST

Parts are listed alphanumerically in order of their circuit designations. Table 6-1 contains parts list information for the mother board. Table 6-2 contains parts list information for the display board. Table 6-3 contains a parts list for the Model 1758 Battery Pack.

Miscellaneous replaceable parts are not listed in a table and can be identified in Figures 6-1 and 6-2. Table 6-4 contains a complement of spare parts that can be ordered to maintain up to ten Model 175-AV units for approximately one year.

6.3 ORDERING INFORMATION

To place an order, or to obtain information concerning replacement parts, contact your Keithley representative or the factory. See inside front cover for addresses. When ordering, include the following information:

- Instrument model number
- Instrument serial number
- Parts description
- Circuit designation (if applicable)
- Keithley part number

If an additional instruction manual is required, order the manual package (Keithley part number 175-AV-901-00). The manual package contains an instruction manual and any applicable addenda.

6.4 FACTORY SERVICE

If the instrument is to be returned to the factory for service, please complete the service form, which follows this section, and return it with the instrument.

6.5 SCHEMATIC DIAGRAMS AND COMPONENT LOCATION DRAWINGS

Schematic diagrams and component location drawings follow the appropriate replaceable parts list for that particular board.

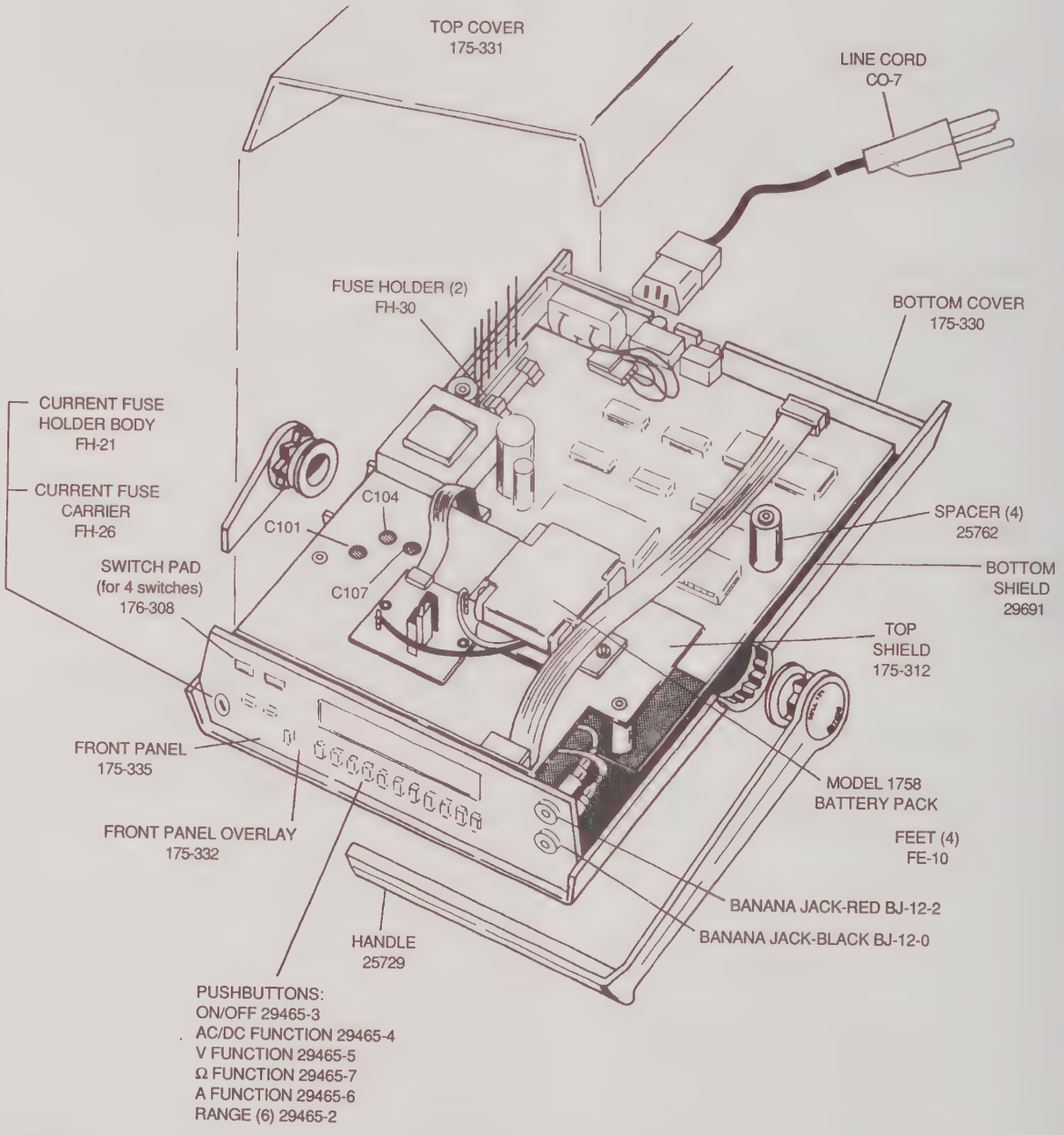


Figure 6-1. Model 175-AV Miscellaneous Parts

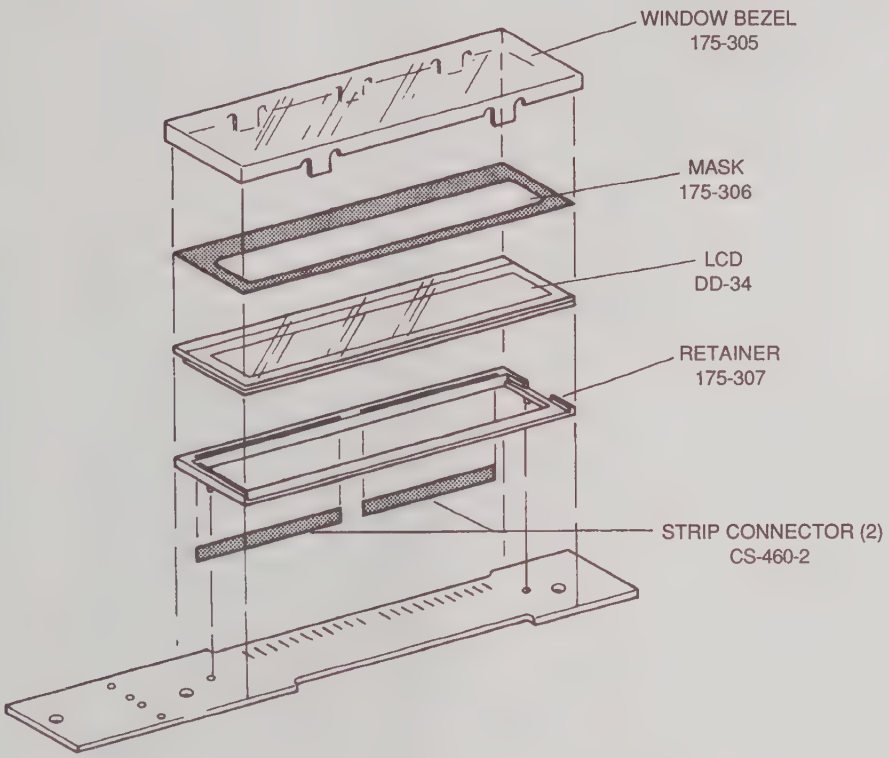


Figure 6-2. Display Assembly

Table 6-1. Mother Board, Parts List

Circuit Design.	Description	Keithley Part No.	Location Sch*	Pcb
C101	Capacitor, 1.5pF	C-184	B2-1	C2
C102	Capacitor, 6.2pF, 1000V, Ceramic Disk	C-349-6.2p	B2-1	C2
C103	Capacitor, 15pF, 100V, 5%, Ceramic	C-372-15p	B2-1	C2
C104	Capacitor, Trimmer, 3-10pF, 500V	C-346	B2-1	C2
C105	Capacitor, 8200pF, 50V, 1%, Ceramic	C-347-8200p	C2-1	D2
C106	Capacitor, .02µF, 500V, 2%, Ceramic Disk	C-316-.02	B1-1	C2
C107	Capacitor, Trimmer, 7-70pF, 500V, Ceramic Disk	C-345	C2-1	D2
C108	Capacitor, 710pF, 50V, 2%, Ceramic	C-348-710p	B2-1	D2
C109	Capacitor, .01µF, 630V, 10%, Metalized Polypropylene	C-360-.01	D2-1	C2
C110	Capacitor, .01µF, 100VDC, 10%, Metal Polypropylene	C-306-.01	E3-1	D3
C111	Capacitor, 1µF, 50VDC, 20%, Metalized Polyester	C-350-1	G1-1	C3
C112	Capacitor, 15µF, 20V, 10%, Tantalum	C-204-15	E1-1	C4
C113	Capacitor, 1µF, 50V, Ceramic Film	C-237-1	F1-1	C4
C114	Capacitor, .1µF, 50V, Cermic Film	C-237-.1	E1-1	C4
C115	Capacitor, 22pF, 630V, 2.5%, Polypropylene	C-405-22p	F1-1	C4
C116	Capacitor, 10µF, 25V, Aluminum Electrolytic	C-314-10	G2-1	C5
C117	Capacitor, .01µF, 100VDC, 10%, Metal Polypropylene	C-306-.01	C1-2	C5
C118	Capacitor, 1500µF, 25V, Aluminum Electrolytic	C-314-1500	F1-2	E2
C119	Capacitor, 4.7µF, 25V, Aluminum Electrolytic	C-314-4.7	G1-2	E2
C120	Capacitor, 4.7µF, 25V, Aluminum Electrolytic	C-314-4.7	G1-2	E2
C121	Capacitor, 220µF, 25V, Aluminum Electrolytic	C-314-220	G2-2	E3
C122	Capacitor, 4.7µF, 25V, Aluminum Electrolytic	C-314-4.7	G1-2	E3
C123	Capacitor, 1µF, 50V, Ceramic Film	C-237-1	H3-2	D4
C124	Capacitor, .1µF, 50V, Ceramic Film	C-237-.1	F3-2	F4
C125	Capacitor, 22pF, 1000V, 10%, Ceramic Disk	C-64-22p	E6-2	F5
C126	Capacitor, 22pF, 1000V, 10%, Ceramic Disk	C-64-22p	E6-2	F5
C127	Capacitor, .1µF, 50V, Ceramic Film	C-237-.1	B5-2	E5
C128	Capacitor, .1µF, 50V, Ceramic Film	C-237-.1	D6-2	E5
C129	Capacitor, .1µF, 50V, Ceramic Film	C-237-.1	F4-2	F4
C130	Capacitor, .1µF, 50V, Ceramic Film	C-237-.1	E6-2	F4
C131	Capacitor, .1µF, 50V, Ceramic Film	C-237-.1	D6-2	F4
C132	Capacitor, 1µF, 50VDC, 20%, Metalized Polyester	C-350-1	G1-1	B3
CR101	Not Used	-	-	-
CR102	Rectifier, REC40100	RF-36	A3-1	B5
CR103	Diode, Silicon, 1N5400	RF-34	A4-1	C5
CR104	Bridge Rectifier, VM18	RF-52	F1-2	D3
J1001	Connector, AC Receptacle	CS-254	E2-2	-
J1002	Connector, Male, Modified	175-316	E1-2	-
J1006	Socket, 14 pin, for display	SO-70	G4-2	F5
J1009	Connector, Battery Option	CS-389-4	G2-2	D3
-	Socket, 40 pin, for U114	SO-84-40	-	E4
-	Socket, 40 pin, for U123	SO-84-40	-	F5
-	Socket, 28 pin, for U115	SO-69	-	E5
K101	Relay, High Voltage, 5V	RL-82	C1,5-1	C3
K102	Relay, Reed	RL-59	C2,5-1	C3
K103	Relay, Reed	RL-59	C2,5-1	D2
P1002	Connector, Housing, Female	CS-287-3	E1-2	E2
P1008	Connector, IEEE, Modified	175-321	A4-2	F1

*Zone and page number (e.g., B2-1) corresponds to zone B2 of schematic page 1.

Table 6-1. Mother Board, Parts List (Cont.)

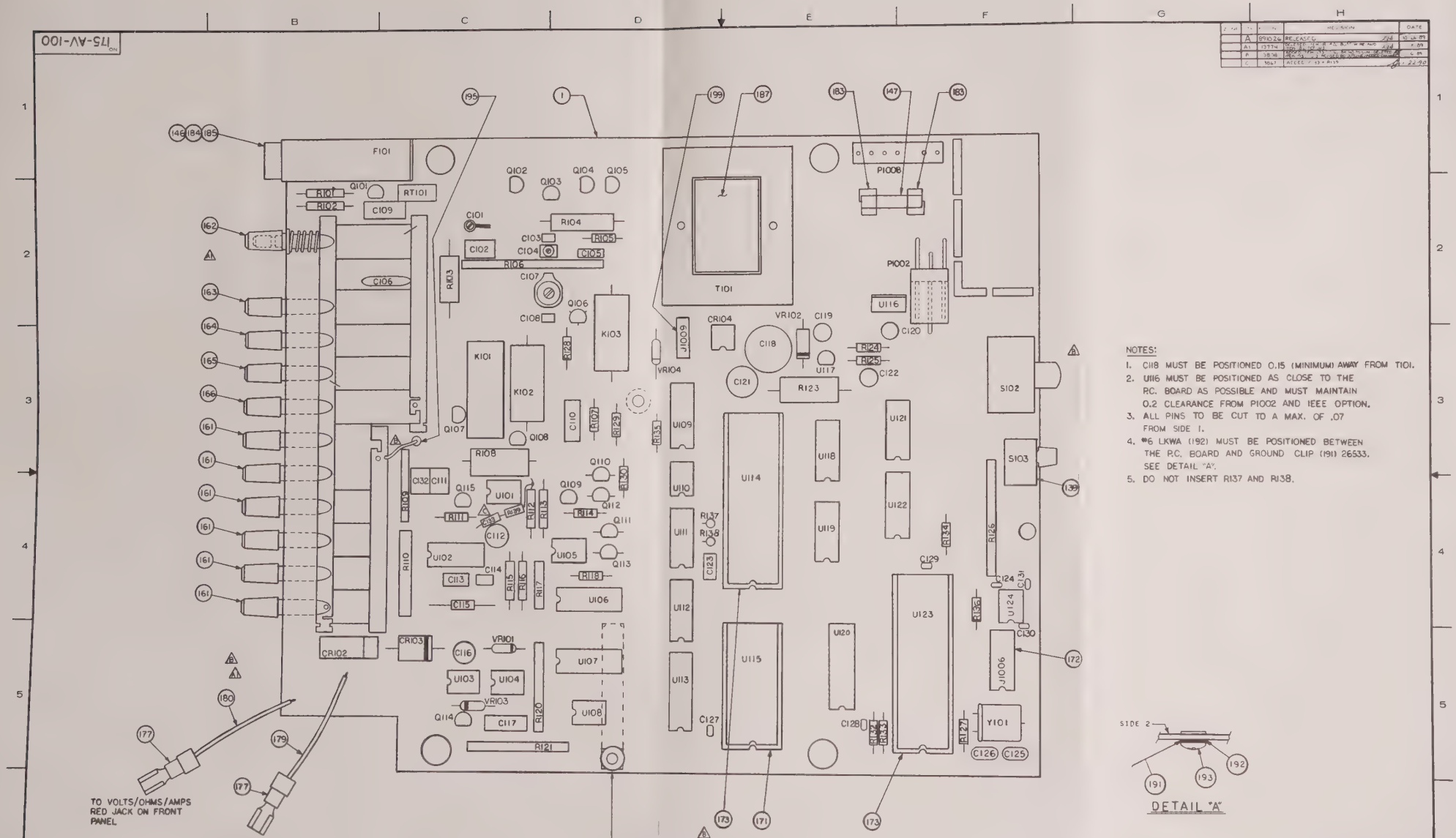
Circuit Design.	Description	Keithley Part No.	Location Sch*	Pcb
Q101	Transistor, NPN, 2N3904	TG-47	D2-1	B2
Q102	Transistor, NPN, 2N5089	TG-62	C3-1	C2
Q103	Transistor, NPN, 5818	TG-138	D3-1	D2
Q104	Transistor, Selection, TG-62	175-601	D3-1	D2
Q105	Transistor, Selection, TG-62	175-601	D3-1	D2
Q106	JFET, P-Channel, J270	TG-166	B2-1	D2
Q107	Transistor, Selection, TG-62	175-601	D1-1	C3
Q108	Transistor, Selection, TG-62	175-601	D1-1	C3
Q109	Transistor, NPN, 2N3904	TG-47	G3-1	D4
Q110	JFET, N-Channel, J210	TG-167	F3-1	D3
Q111	JFET, N-Channel, J210	TG-167	F3-1	D4
Q112	JFET, N-Channel, J210	TG-167	F4-1	D4
Q113	JFET, N-Channel, J210	TG-167	F4-1	D4
Q114	FET, N-Channel	TG-128	B1-2	C5
Q115	Transistor, NPN, 2N5089	TG-62	E1-1	C4
R101	Resistor, 1kΩ, 1%, 1/8W, Metal Film	R-177-1k	D2-1	B2
R102	Resistor, 99kΩ, 1%, 1/8W, Metal Film	R-177-99k	D3-1	B2
R103	Resistor, 220kΩ, 10%, 1W, Composition	R-2-220k	B1-1	C2
R104	Resistor, 402kΩ, 1%, 1/2W, Deposited Carbon	R-12-402k	D3-1	D2
R105	Resistor, 1MΩ, 5%, 1/4W, Composition	R-76-1M	E4-1	D2
R106	Thick Film Resistor Network	TF-170	Sev	C2
R107	Resistor, 390kΩ, 5%, 1/4W, Composition	R-76-390k	E3-1	D3
R108	Resistor, 43kΩ, 5%, 2W, Composition	R-320-43k	D1-1	C3
R109	Thick Film Resistor Network	TF-168-1	B3-1	C4
R110	Resistor, Divider, 0.0999Ω, and 0.999Ω, 0.1%, 1W and 2W	R-318	B4-1	C4
R111	Resistor, 10kΩ, 5%, 1/4W, Composition	R-76-10k	D1-1	C4
R112	Resistor, 2.5kΩ, 0.1%, 1/8W	R-176-2.5k	E1-1	C4
R113	Resistor, 1.6kΩ, 0.1%, 1/8W	R-176-1.6k	E1-1	C4
R114	Resistor, 200kΩ, 5%, 1/4W, Composition	R-76-200k	F3-1	D4
R115	Resistor, 100kΩ, 0.1%, 1/8W	R-176-100k	F1-1	C4
R116	Resistor, 76.8kΩ, 0.1%, 1/8W	R-176-76.8k	F1-1	C4
R117	Thick Film Resistor Network	TF-169	Sev	C4
R118	Resistor, 3.3kΩ, 5%, 1/4W, Composition	R76-3.3kΩ	F4-1	D4
R119	Not Used	-	-	-
R120	Thick Film Resistor Network	TF-171	Sev	C5
R121	Thick Film Resistor Network	TF-172	Sev-2	C5
R122	Not Used	-	-	-
R123	Resistor, 22Ω, 10%, 2W, Composition	R-3-22	F1-2	E3
R124	Resistor, 8.06kΩ, 1%, 1/8W, Composition	R-88-8.06k	G1-2	E3
R125	Resistor, 1.24kΩ, 1%, 1/8W, Composition	R-88-1.24k	G2-2	E3
R126	Thick Film Resistor Network	TF-173	Sev	F4
R127	Thick Film, 10MΩ, 1/4W, Composition	R-76-10M	F6-2	F5
R128	Thick Film, 2.2kΩ, 5%, 1/4W, Composition	R-76-2.2k	C2-1	D3
R129	Resistor, 200kΩ, 5%, 1/4W, Composition	R-76-200k	F3-1	D3
R130	Resistor, 200kΩ, 5%, 1/4W, Composition	R-76-200k	F4-1	D4
R131	Not Used	-	-	-
R132	Resistor, 1kΩ, 5%, 1/4W, Composition	R-76-1k	G6-2	E5
R133	Resistor, 1kΩ, 5%, 1/4W, Composition	R-76-1k	H5-2	E5

*Zone and page number (e.g., B2-1) corresponds to zone B2 of schematic page 1.

Table 6-1. Mother Board, Parts List (Cont.)

Circuit Design.	Description	Keithley Part No.	Location Sch*	Pcb
R134	Resistor, 22kΩ, 5%, 1/4W, Composition	R-76-22k	B4-2	F4
R135	Resistor, 47kΩ, 5%, 1/4W, Composition	R-76-47k	H5-2	D3
R136	Resistor, 2kΩ, 5%, 1/4W, Composition	R-76-2k	E5-2	F4
RT101	Thermistor, 4150Ω, 10%, 17.5mA	RT-9-1	D3-1	C2
S101	Switches, pushbuttons	SW-448	Sev	B2-B4
S102	Line Switch	SW-318	E1-2	F3
S103	Calibration Switch	SW-465	H4-2	F3
T101	Transformer, Power (105-125V, 210-250V)	TR-201	F1-2	D2
U101	JFET Op Amp, LF411CN	IC-248	E1-1	C4
U102	RMS to DC Converter, 637JD	IC-352	F1-1	C4
U103	Programmable Op Amp, TLC271	IC-347	F2-1	C5
U104	Op Amp, TL061CP	IC-227	C1-2	C5
U105	IC, Selection, IC-347	175-600	G3-1	D4
U106	Triple 2-Channel Analog Multiplexer, CD4053BC	IC-283	Sev	D4
U107	Triple 2-Channel Analog Multiplexer, CD4053BC	IC-283	Sev	D5
U108	Dual Voltage Comparator, LM393	IC-343	C2-2	D5
U109	Triple 2-Channel Analog Multiplexer, CD4053BC	IC-283	Sev	D3
U110	16 x 16 Bit Serial Nonvolatile Static RAM, X2443P	IC-353	H4-2	D4
U111	Hex Inverter, 74HC04	IC-354	D5-1	D4
U112	Quad 2-Input NAND Gate, 74HC00	IC-351	C4-1	D4
U113	1024 x 4 Bit Static CMOS RAM	LSI-62	A5-2	D5
U114	Peripheral Interface Adapter, 65C21	LSI-61	B3-2	E4
U115	8K x 8 Bit UV Erasable PROM	175-AV-800-**	B5-2	E5
U116	Regulator, +5V, 1A, 7805	IC-93	G1-2	E3
U117	3-Terminal Adjustable Regulator, LM337L	IC-345	G2-2	E3
U118	Triple 3-Input OR Gate, CD4075BE	IC-143	Sev	E3
U119	Triple 3-Input NAND Gate, MM74HC10	IC-341	Sev	E4
U120	Tri-State Octal D Latch, 74HC373	IC-338	D5-2	E5
U121	Dual D Flip-Flop, 74HC74	IC-337	E2-2	F3
U122	12 Stage Binary Counter, 4040B	IC-348	D3-2	F4
U123	CMOS 8-Bit Microprocessor, 146805E2	LSI-60	F3-2	F5
U124	Supply Voltage Supervisor, TL7705AC	IC-602	E5-2	F4
VR101	Diode, Zener, 6.35V, 400mW, 1N4577	DZ-58	F2-1	C5
VR102	Diode, Zener, 12V, 5W, 1N5349	DZ-72-1	G1-2	E3
VR103	Diode, Zener, 5.1V, 400mW, 1N751	DZ-59	G2-1	C5
VR104	Diode, Zener, 12V, 1N963B	DZ-54	H1-2	D3
Y101	Crystal, 3.2768MHz	CR-21	E6-2	F5

* Zone and page number (e.g., B2-1) corresponds to zone B2 of schematic page 1.
** Order same software as presently installed. For example, if A1 is the displayed software order 175-AV-800-A1.



NOTES:

1. C118 MUST BE POSITIONED 0.15 (MINIMUM) AWAY FROM T101.
2. U116 MUST BE POSITIONED AS CLOSE TO THE P.C. BOARD AS POSSIBLE AND MUST MAINTAIN 0.2 CLEARANCE FROM P1002 AND IEEE OPTION.
3. ALL PINS TO BE CUT TO A MAX. OF .07 FROM SIDE 1.
4. #6 LKWA (192) MUST BE POSITIONED BETWEEN THE P.C. BOARD AND GROUND CLIP (191) 26533. SEE DETAIL "A".
5. DO NOT INSERT R137 AND R138.

REV	LTR	REVISION	DATE
	A	891026 RELEASED	10 JAN 89
	A1	13774	4 JUL 89
	B	3838	6 JUL 89
	C	3867	1 AUG 90

175-AV	1
MODEL	NEXT ASSEMBLY

KEITHLEY Keithley Instruments Inc.

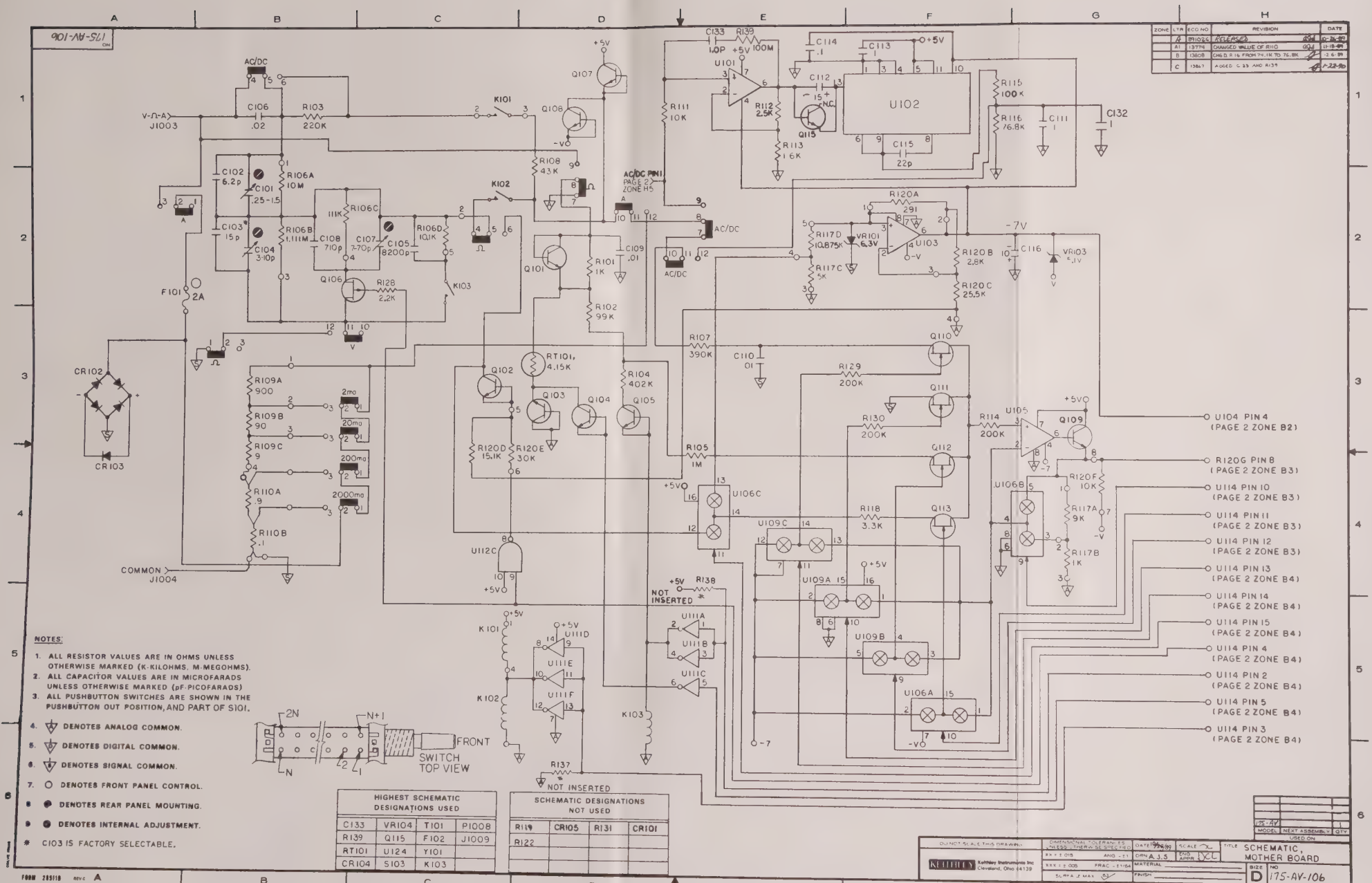
DATE 11-26-85 | SCALE 2:1 | BY A.J.S | TECH DCL | MATERIAL | FINISH

TITLE COMPONENT LAYOUT, MOTHER BOARD

SIZE D | NO 175-AV-100

FORM 28511D -- A

H PAGE 1 OF 2



ZONE	LTR	ECO NO	REVISION	DATE
	A	891025	RELEASED	10-25-89
	A1	13774	CHANGED VALUE OF R110	QA 11-13-89
	B	13808	CHG'D R 16 FROM 74.1K TO 76.8K	12-6-89
	C	13867	ADDED C 33 AND R139	A 2-23-90

NOTES:

1. ALL RESISTOR VALUES ARE IN OHMS UNLESS OTHERWISE MARKED (K-KILOHMS, M-MEGOHMS).
2. ALL CAPACITOR VALUES ARE IN MICROFARADS UNLESS OTHERWISE MARKED (pF-PICOFARADS)
3. ALL PUSHBUTTON SWITCHES ARE SHOWN IN THE PUSHBUTTON OUT POSITION, AND PART OF S101.
4. ▽ DENOTES ANALOG COMMON.
5. ▽ DENOTES DIGITAL COMMON.
6. ▽ DENOTES SIGNAL COMMON.
7. ○ DENOTES FRONT PANEL CONTROL.
8. ● DENOTES REAR PANEL MOUNTING.
9. ● DENOTES INTERNAL ADJUSTMENT.
- * C103 IS FACTORY SELECTABLE.

HIGHEST SCHEMATIC DESIGNATIONS USED			
C133	VR104	T101	P1008
R139	Q115	F102	J1009
RT101	U124	Y101	
CR104	S103	K103	

SCHEMATIC DESIGNATIONS NOT USED			
R119	CR105	R131	CR101
R122			

DO NOT SCALE THIS DRAWING — UNLESS OTHERWISE SPECIFIED — DIMENSIONAL TOLERANCES: XX ± .01, ANG ± 1°, XXX ± .005, FRAC ± 1/64, SURFACE MAX 63 — DATE 10-25-89 — DRN A.J.S. — ENG APPR LCL — MATERIAL — FINISH

KEITHLEY Keithley Instruments Inc Cleveland, Ohio 44139

TITLE SCHEMATIC, MOTHER BOARD

SIZE D — NO 175-AV-106

175-AV — MODEL — NEXT ASSEMBLY — QTY — USED ON

FORM 28511B REV A

SHEET 1OF2

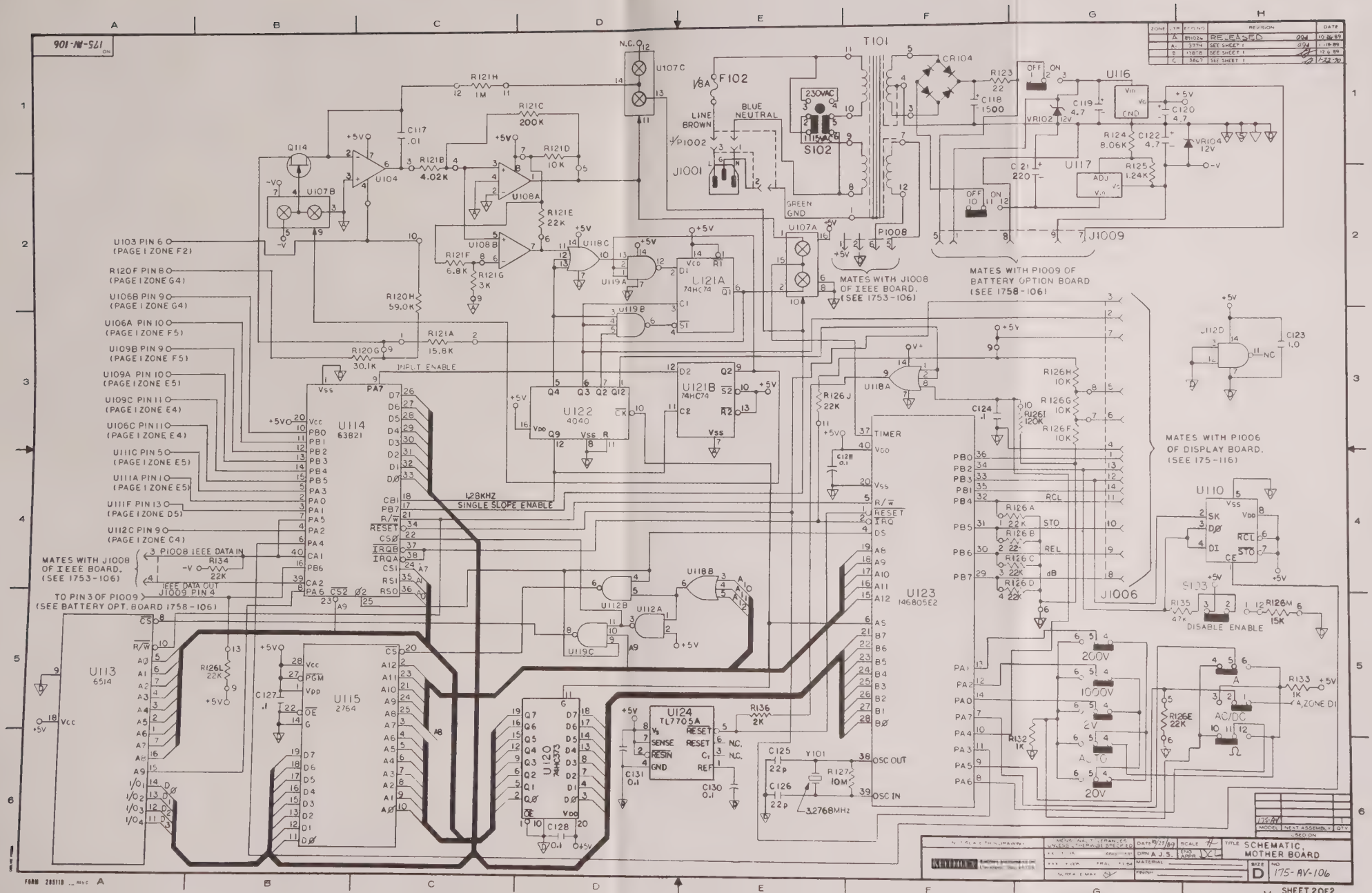
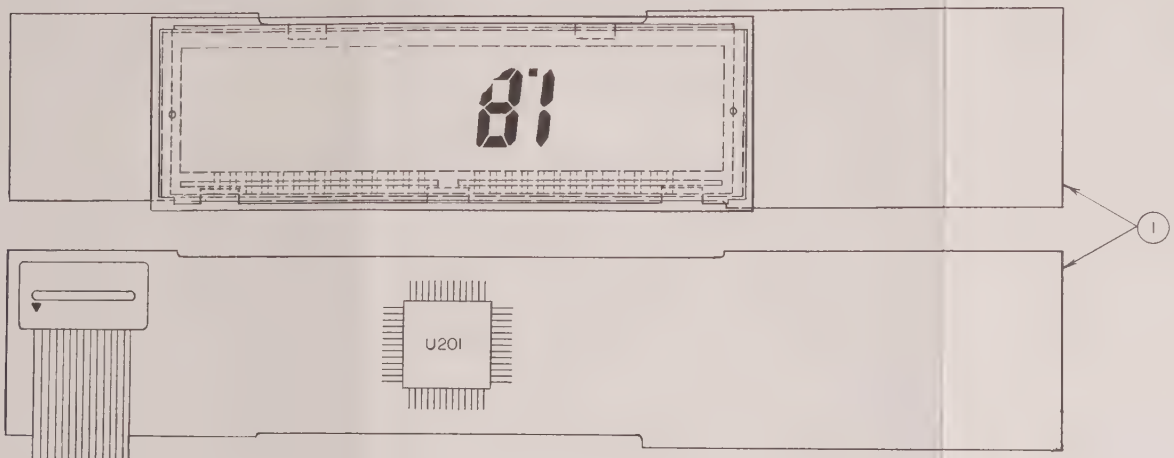

U114 63821
U113 6514
U115 2764
U120 74HC373
U121A 74HC74
U121B 74HC74
U122 4040
U123 146805E2
U124 TL7705A
U104
U107B
U107C
U108A
U108B
U108C
U116
U117
U118A
U118B
U119A
U119B
U119C
U112A
U112B
U112D
U110
T101
F102
S102
J1001
P1002
P1008
J1009
J1006
CR104
VR102 12V
VR104 12V
Q114
R121H 1M
R121C 200K
R121B 4.02K
R121D 10K
R121E 22K
R121F 6.8K
R121G 3K
R120H 59.0K
R121A 15.8K
R120G 30.1K
R123 22
R124 8.06K
R125 1.24K
R126H 10K
R126G 10K
R126F 10K
R126J 22K
R126A 22K
R126B 22K
R126C 22K
R126D 22K
R126L 22K
R126E 22K
R126M 15K
R134 22K
R135 47K
R136 2K
R132 1K
R133 1K
R127 10M
C117 .01
C118 1500
C119 4.7
C120 4.7
C121 220
C122 4.7
C123 1.0
C124 .1
C125 22p
C126 22p
C127 .1
C128 0.1
C130 0.1
C131 0.1
Y101 32.768MHz
INPUT ENABLE
128KHZ SINGLE SLOPE ENABLE
DISABLE ENABLE
MATES WITH J1008 OF IEEE BOARD. (SEE 1753-106)
MATES WITH P1008 IEEE DATA IN
IEEE DATA OUT J1009 PIN 4
TO PIN 3 OF P1009 (SEE BATTERY OPT. BOARD 1758-106)
MATES WITH J1008 OF IEEE BOARD. (SEE 1753-106)
MATES WITH P1009 OF BATTERY OPTION BOARD (SEE 1758-106)
MATES WITH P1006 OF DISPLAY BOARD. (SEE 175-116)
LINE BROWN
NEUTRAL BLUE
GREEN GND
230VAC
115VAC
200V
1000V
2V
AUTO
20V
AC/DC
Ω
A
SCHEMATIC, MOTHER BOARD
175-AV-106
SHEET 2OF2

Table 6-2. Display Board, Parts List

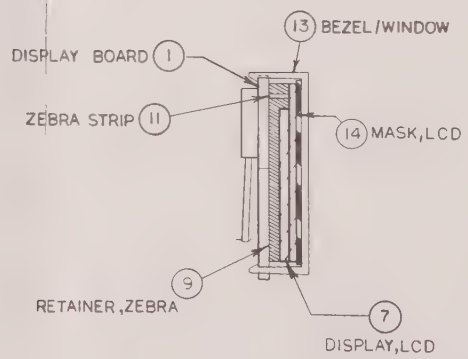
Circuit Desig.	Description	Keithley Part No.	Location Sch	Location Pcb
DS-201	Liquid Crystal Display	DD-34	Sev	C2
P1006	Cable Assembly (14 Conductor)	CA-9-3	C5	B3
U201	LCD Controller/Driver	LSI-59	D4	C3

175-110 ON

ZONE	LTR	ECO NO	REVISION	ENG	DATE
	A	9394	RELEASED	[illegible]	8/21/83
	B	9627	CHANGED ARTWORK WAS REV H	MAL	1-16-84
	C	9659	REVISED D. ART WAS REV B	MAL	1-20-84
	D	9745	ARTWORK [illegible] WAS REV G	[illegible]	7-5-84



ITEM	PART NO.	SCHEM. DESIG.	ZONE	
1	175-325	SUB,COMP	G2	
2				
3	CA-9-3	P1006	B3	REFERENCE
4				
5	LSI-59	U201	C3	REFERENCE
6				
7	DD-34	DS-201	C2	
8				
9	175-307	———	C2	
10				
11	CS-460-2	2/U	C2/D2	
12				
13	175-305	———	C2	
14	175-306	———	C2	
15				
16				
17				
18				
19				
20				



MODEL	NEXT ASSEMBLY	QTY
175		

USED ON

DO NOT SCALE THIS DRAWING

DIMENSIONAL TOLERANCES UNLESS OTHERWISE SPECIFIED
XX = ± .015 ANG = ±1°
XXX = ± .005 FRAC = ±1/64
SURFACE MAX 63

DATE 8/22/83 DRN VA ENG APPR

SCALE 2:1

MATERIAL

FINISH

TITLE COMPONENT LAYOUT, DISPLAY BOARD

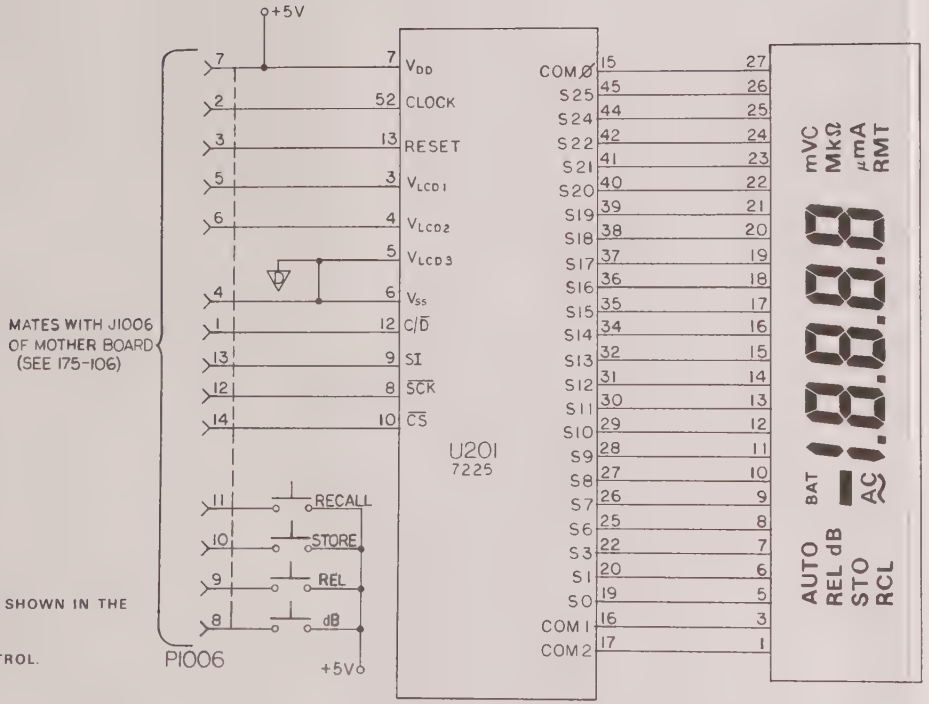
KEITHLEY Keithley Instruments Inc. Cleveland, Ohio 44139

SIZE C NO 175-110

FORM 30152C REV D

175-116 ON

ZONE	LTR	ECO NO	REVISION	ENG	DATE
	A	9504	RELEASED		11-18-83



CONTACT DESCRIPTION

CONTACT Nº	COMØ	COM1	COM2
1	—	—	COM2
2	—	—	—
3	—	COM1	—
4	—	—	—
5	AUTO	REL	STO
6	dB	AC	RCL
7	BAT	—	1
8	5f	5e	5dp
9	5a	5g	5d
10	5b	5c	—
11	4f	4e	4dp
12	4a	4g	4d
13	4b	4c	—
14	3f	3e	3dp
15	3a	3g	3d
16	3b	3c	—
17	2f	2e	2dp
18	2a	2g	2d
19	2b	2c	—
20	—	—	—
21	—	—	—
22	—	—	—
23	m	M	µ
24	V	k	m
25	C	Ω	A
26	—	—	RMT
27	COMØ	—	—

NOTES:

1. ALL PUSHBUTTON SWITCHES ARE SHOWN IN THE PUSHBUTTON OUT POSITION.
2. ○ DENOTES FRONT PANEL CONTROL.
3. ▽D DENOTES DIGITAL COMMON.

HIGHEST SCHEMATIC DESIGNATIONS USED			
U201			

SCHEMATIC DESIGNATIONS NOT USED			

MODEL	NEXT ASSEMBLY	QTY
175		

USED ON

DO NOT SCALE THIS DRAWING

KEITHLEY Keithley Instruments Inc. Cleveland, Ohio 44139

DIMENSIONAL TOLERANCES UNLESS OTHERWISE SPECIFIED
XX = ± .015 ANG = ±1°
XXX = ± .005 FRAC = ±1/64
SURFACE MAX 63

DATE
DRN VA
ENG APPR MH

SCALE A

TITLE SCHEMATIC, DISPLAY BOARD

MATERIAL

FINISH

C NO 175-116

FORM 30152C REV D

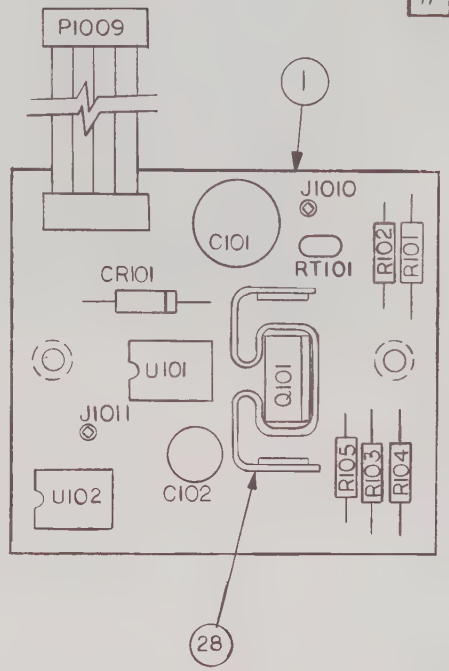
Table 6-3. Model 1758 Battery Pack, Parts List

Circuit Desig.	Description	Keithley Part No.	Location Sch	Location Pcb
BT-101	Battery Assembly, 9.6V sealed rechargeable Ni Cad	BA-38	B3	-
C101	Capacitor, 220µF, 25VDC, Aluminum Electrolytic	C-314-220	D4	D2
C102	Capacitor, 10µF, 25VDC, Aluminum Electrolytic	C-314-10	C4	D3
CR101	Rectifier, Schottky Barrier, 1N5820	RF-53	D4	D3
P1009	Cable Assembly, 10 Conductor	CA-27-1	B1	C1
Q101	Transistor, NPN, High Voltage (TIP-49)	TG-137	C2	D3
R101	Resistor, 4.7Ω, 10%, 1W, Wirewound	R-334-4.7	C3	D2
R102	Resistor, 4.7Ω, 5%, 1/4W, Composition	R-76-4.7	C2	D2
R103	Resistor, 30.1kΩ, 1%, 1/8W, Metal Film	R-88-30.1k	D3	D3
R104	Resistor, 39.2kΩ, 1%, 1/8W, Metal Film	R-88-39.2k	E3	D3
R105	Resistor, 1.2MΩ, 5%, 1/4W, Composition	R-76-1.2M	E3	D3
RT101	Thermistor, PTC, .30Ω	RT-10	B2	D2
U101	Voltage Converter, SI7661CJ	IC-340	C4	D3
U102	Voltage Comparator, LM393	IC-343	E3	D3
-	Heat Sink (used on Q101)	HS-28	-	D3
-	Standoff (Battery Board to Shield)	ST-137-6	-	-
-	Battery Bracket	1758-305	-	-

1758-100 ON

LTR	ECO NO	REVISION	ENG	DATE
A		PRELIMINARY		
B		PRELIMINARY		
C	9450	RELEASED		9/30/83
D	9572	REF. WAS Rev C ADDED Items 15 ITEM 17 WAS R-76.	Mule	1-24-84
E	9806	ITEMS 11 & 12 WERE CS-357 DELETED DETAIL "A"	Mule	4-7-84
F	10402	R101 WAS R-1-4.7	JMS	12-27-84
G	10967	ARTWORK WAS REV. D	SJ	2-20-86
H	12058	CHG'D ITEM 3 FROM C-314-250 TO C-314-220	SJ	4-3-87

ITEM	PART NO.	SCHEM. DESIG.	ZONE
1	1758-101	STAKING	D2
2			
3 (H)	C-314-220	C101	D2
4	C-314-10	C102	D3
5			
6	CA-27-1	P1009	C1
7	IC-340	U101	D3
8	IC-343	U102	D3
9			
10			
11 (E)	CS-463	J1011	D3
12 (E)	CS-463	J1010	D2
13			
14	TG-137	Q101	D3
15			
16			
17 (E)(D)	R-334-4.7	R101	D2
18	R-76-4.7	R102	D2
19	R-88-30.1K	R103	D3
20	R-88-39.2K	R104	D3
21	R-76-1.2M	R105	D3
22			
23	RF-53	CR101	D3
24			
25 (D)	RT-10	RT101	D2
26			
27			
28	HS-28		D3
29			



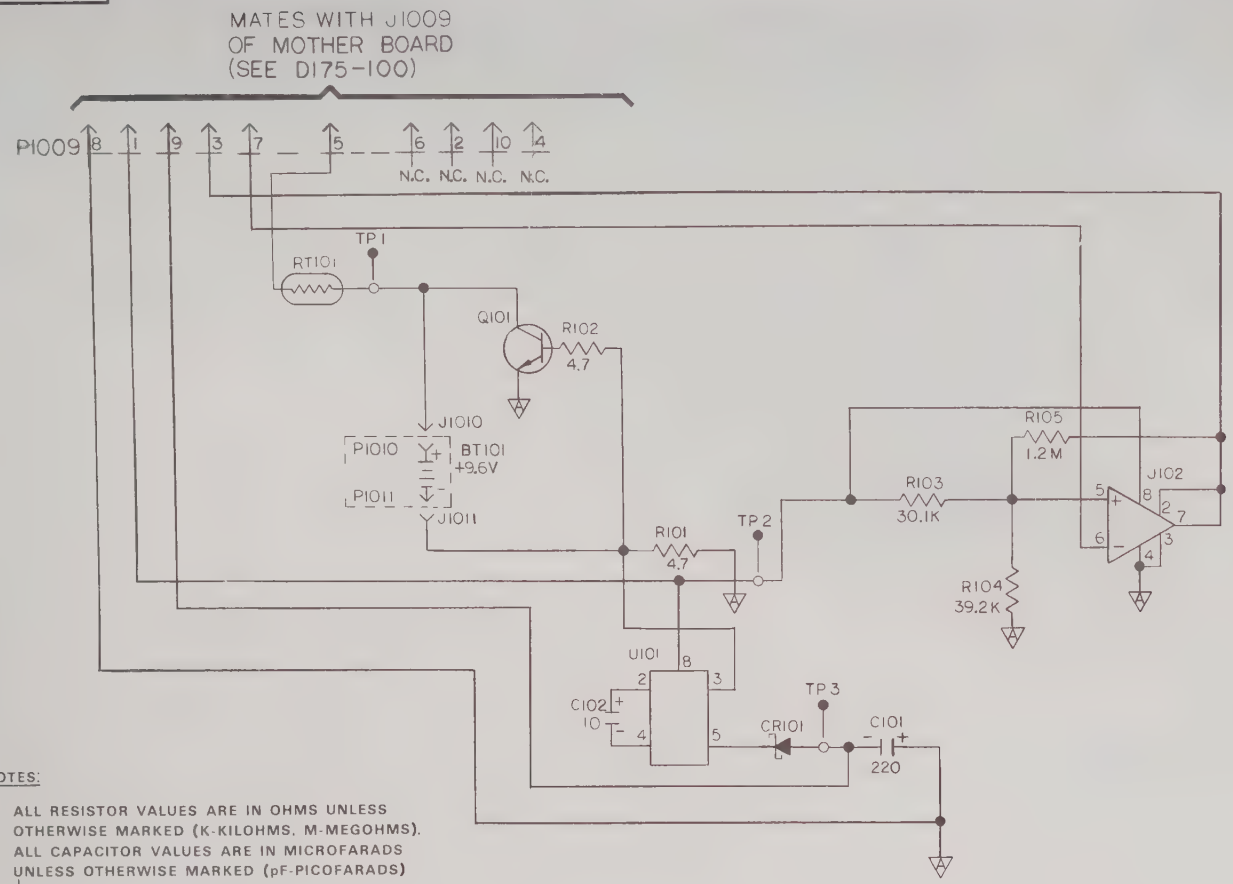
1758		
MODEL	NEXT ASSEMBLY	QTY.
USED ON		

DO NOT SCALE THIS DRAWING	DIMENSIONAL TOLERANCES UNLESS OTHERWISE SPECIFIED	DATE 6-24-83	SCALE 2:1	TITLE COMPONENT LAYOUT BATTERY OPTION
KEITHLEY Keithley Instruments Inc. Cleveland, Ohio 44139	XX = ± .015 ANG. = ±1°	DRN. B.S.	ENG. APPR. MA	
	XXX = ± .005 FRAC. = ±1/64	MATERIAL	SIZE B	NO. 1758-100
	SURFACE MAX 63	FIN'SH		

BRUNING 44-131 58425 FORM 282776 REV D

1758-106 ON

ZONE	LTR	ECO NO	REVISION	ENG	DATE
	A	9450	RELEASED		9/30/83
	B	9572	ADDED R110		11-24-84
	C	12058	CHG'D VALUE OF R121 FROM 250 TO 332		4/3/87



NOTES:

1. ALL RESISTOR VALUES ARE IN OHMS UNLESS OTHERWISE MARKED (K-KILOHMS, M-MEGOHMS).
2. ALL CAPACITOR VALUES ARE IN MICROFARADS UNLESS OTHERWISE MARKED (pF-PICOFARADS)
3. ▽ DENOTES ANALOG COMMON.
4. —o— DENOTES TEST POINT.

HIGHEST SCHEMATIC DESIGNATIONS USED			
C102	Q101	BT101	R105
U102	RT101		

SCHEMATIC DESIGNATIONS NOT USED			

1758		
MODEL	NEXT ASSEMBLY USED ON	QTY

DO NOT SCALE THIS DRAWING

DIMENSIONAL TOLERANCES UNLESS OTHERWISE SPECIFIED
XX – ± 015 ANG = ±1°
XXX = ± 005 FRAC = ±1/64
SURFACE MAX 63

DATE 7-29-87 SCALE NONE
DRN B.S. ENG APPR. MA
MATERIAL
FINISH

TITLE SCHEMATIC BATTERY OPTION

KEITHLEY Keithley Instruments Inc. Cleveland, Ohio 44139

C NO 1758-106

FORM 30152C REV. D

Table 6-4. Model 175-AV Spare Parts List

Qty	Keithley Part No.	Circuit Desig.
1	BA-38	BT101
4	FU-48	F101
2	FU-91	F102
1	RL-82	K101
1	RL-59	K102-K103
2	TG-62	Q102, Q115
2	TG-138	Q103
4	175-601	Q104, Q105, Q107,Q108
1	TG-166	Q106
4	TG-167	Q110, Q111, Q112,Q113
1	TG-128	Q114
1	RT-9-1	RT101
1	IC-352	U102
1	IC-347	U103
2	IC-283	U106,U107,U109
1	175-600	U105
1	IC-353	U110
1	IC-354	U111
1	IC-351	U112
1	IC-93	U116
1	IC-345	U117
1	DZ-58	VR101
1	DZ-72-1	VR102

KEITHLEY INSTRUMENTS

SERVICE FORM

Model No. _____ **Serial No.** _____ **Date** _____

Name and Telephone No. _____

Company _____

List all control settings, describe problem and check boxes that apply to problem. _____

_____

_____

☐ Intermittent
☐ IEEE failure
☐ Front panel operational
☐ Analog output follows display
☐ Obvious problem on power-up
☐ All ranges or functions are bad
☐ Particular range or function bad; specify _____
☐ Batteries and fuses are OK
☐ Checked all cables

Display or output (circle one)

☐ Drifts
☐ Unstable
☐ Overload
☐ Unable to zero
☐ Will not read applied input

☐ Calibration only
☐ Data required
☐ C of C required

(attach any additional sheets as necessary.)

Show a block diagram of your measurement system including all instruments connected (whether power is turned on or not). Also, describe signal source.

Where is the measurement being performed? (factory, controlled laboratory, out-of-doors, etc.)

_____

_____

What power line voltage is used? _____ Ambient Temperature? _____ °F

Relative humidity? _____ Other? _____

Any additional information. (If special modifications have been made by the user, please describe.) _____

_____

Be sure to include your name and phone number on this service form.

KEITHLEY INSTRUMENTS

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